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BUREAU OF PLANT INDUSTRY—BULLETIN NO. 283.

WILLIAM A. TAYLOR, *Chief of Bureau.*

# CEREAL EXPERIMENTS IN THE TEXAS PANHANDLE.

BY

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# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
*Washington, D. C., January 15, 1913.*

Sir: I have the honor to transmit herewith a manuscript entitled "Cereal Experiments in the Texas Panhandle," prepared by John F. Ross, Farm Superintendent, and Arthur H. Leidigh, formerly Scientific Assistant, Office of Cereal Investigations, under the direction of Carleton R. Ball, Acting Cerealist in Charge, and to recommend its publication as Bulletin No. 283 of the series of this Bureau.

This paper presents the results of extensive experiments with cereals begun in 1903 at Channing, Tex., and continued since 1906 at Amarillo, Tex. The results of less extensive experiments conducted cooperatively at Chillicothe and Dalhart, Tex., are also included.

The transition from ranch and range to farm and crop has been steady in recent years. As the conditions under which crops must be grown in this area are severe compared with those to which most of the settlers have been accustomed in more humid areas and at lower elevations, the demand for information concerning adapted cereals and methods of cereal production in the Panhandle has been and still continues to be very insistent. It is thought that this paper will supply much of the desired information.

The Office of Cereal Investigations desires to express herein its appreciation of the hearty cooperation shown by the Capitol Freehold Land & Investment Co. on its headquarters ranch at Channing through its representative, Mr. Walter Farwell, and by the Chamber of Commerce at Amarillo, Tex., through its various secretaries.

Respectfully,

B. T. Galloway,
*Chief of Bureau.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# CEREAL EXPERIMENTS IN THE TEXAS PANHANDLE.

## INTRODUCTION.

In the fall of 1903 the Office of Cereal Investigations of the Bureau of Plant Industry began definite experimental work in the Texas Panhandle. This was done in response to an increasing demand for information on cereal crops and cropping methods adapted to that general region. The demand came partly from farmers recently settled in the region and partly from the owners of large areas of land situated therein, which they wished to sell profitably in small tracts for farms. Some interest was also manifest among ranchers who desired to grow feedstuffs for their herds.

## PAST AND PRESENT CONDITIONS IN THE PANHANDLE.

The conditions then existing or which had existed in the immediate past were those which formerly obtained over the entire Great Plains area. The land was occupied by immense cattle ranches, used only for grazing purposes. The usually dense growth of short but nutritious grasses, chiefly buffalo grass and blue grama, furnished both winter and summer pasturage for countless numbers of beef cattle, which had no other feed from weaning time to marketing. Under this system, from 15 to 40 acres of grazing land were required for each animal, depending on the nature of the grass cover, the character of the season, and the time of year.

In the half-dozen years previous to 1903 this system had been gradually changing. Overstocking the range had resulted in heavy losses during seasons of drought and in severe winters. A call for feeding crops suited to the plains was coming from ranchers. The demand for new, cheap lands for homes and crop production was increasing. The large ranches were being divided and portions sold for farms. This process is still going on throughout the range country.

Most of the settlers come from the more humid States of the Mississippi Valley area, where conditions are almost entirely different. Some of them bring the proceeds of high-priced lands and

invest heavily; others come with only meager equipment and financial resources. None of them have knowledge of the crop varieties or cropping methods most likely to be successful under the rigorous conditions prevailing on the high, dry plains. But few are helped and many are injured by the partial data and misinformation so commonly sent out to inquirers by land-selling agencies. Few settlers can afford to lose their crops during the first year or two in a new country, and none of them are equipped to discover proper crops and methods by experiment. This is, however, the proper service of the Federal Department of Agriculture and the State experiment stations.

## LOCATIONS OF THE EXPERIMENTAL WORK.

It was under the conditions outlined briefly in the foregoing paragraphs that experimental work was undertaken in the Texas Panhandle. Investigations began on August 20, 1903, when the junior writer was assigned to the work in that region. Cooperation was effected with the management of the Capitol Freehold Land & Investment Co., because of their desire to obtain feed grains for their horses and a part of their cattle.

The principal experiments were conducted on the XIT ranch of this company at Channing, Tex., from October 10, 1903, to the end of the cropping season of 1906, and at Amarillo, Tex., after that date. In the fall of 1905 part of the work was transferred to farm No. 1 at Amarillo, where a much broader plan of experimentation was adopted for 1906 and the following years. The year 1906 being the first one at Amarillo and the final one at Channing, the tests were arranged so that those at Channing were largely with the most successful varieties as indicated by the results up to that time. The Channing data for 1906 therefore cover a much smaller number of varieties and deal more with cultural methods and results on larger plats.

The success attending these early operations was so marked that the work expanded rapidly, and other offices of the Bureau of Plant Industry availed themselves of the opportunity to conduct experiments at Amarillo in cooperation with the Office of Cereal Investigations. In 1908, farm No. 2 at Amarillo was obtained and equipped to continue the work which was then being closed on farm No. 1, because, owing to its proximity to the growing city, a renewal of the lease could not be had. The actual transfer of the work to the second farm was made between the cropping seasons of 1909 and 1910. The conditions existing there are treated briefly after the consideration of the experiments at Channing and on the first Amarillo farm.

From the standpoints of climate and crop production, the points of operation are representative of almost all the Texas Panhandle and also of a large part of eastern New Mexico and western Oklahoma. The area contains about 25,000 square miles; the experiments were planned to benefit the settlers throughout this region.

### NATURE OF THE EXPERIMENTS.

The lines of experimentation which were pursued included the introduction, comparison, and improvement of varieties of cereal crops, tests of soil tillage, seeding and cultivation methods, and a study of crop rotations to determine those best adapted to profitable crop production and soil improvement. Some years after the work was begun the tillage and rotation experiments of a general nature were placed under the charge of a newly created office of the Bureau of Plant Industry, designated as Dry-Land Agriculture. The experiments so transferred, as well as those conducted since by that office, as also experimental work conducted cooperatively with other offices of the Bureau, are presented here simply as parts of the work conducted at the Amarillo Cereal Field Station.

After the work of the Office of Cereal Investigations was started in the Panhandle two stations were established for work in that region by other offices of the Bureau of Plant Industry. One of these is a cooperative forage-testing station at Chillicothe, Tex., maintained by the Office of Forage-Crop Investigations and the State of Texas. The other is a farm of the Office of Dry-Land Agriculture at Dalhart, Tex. Varietal tests of grains have been conducted cooperatively on a small scale at both points. The results obtained and the conditions existing at the time are treated briefly in this bulletin.

## GENERAL PHYSICAL DATA FOR THE PANHANDLE.

### LOCATION.

Strictly speaking, the "Panhandle" is the designation applied to that part of northwestern Texas which extends northward from the main body of the State. In common practice, however, this term is usually applied to the entire northwestern part of the State, including the so-called "Staked Plains." The word is here used in the broader sense. Figure 1 is a sketch map of this region. No definite eastern or southern boundary for the Panhandle has ever been fixed, though the eastern boundary is generally held to be the escarpment locally known as the "cap rock," which roughly approximates the line of the 2,000-foot contour. The results given herein are applicable to all the region lying above the level of 2,000 feet and to a

considerable extent to the lower elevations. They apply also to the adjacent similar areas in New Mexico, Colorado, Oklahoma, and Kansas.

FIG. 1.—Sketch map of the Panhandle region of Texas and the surrounding country. The Panhandle region as discussed in this bulletin is indicated by the shaded boundary.

## ELEVATION AND DRAINAGE.

The western half or two-thirds of this region is a high and nearly level table-land with an average altitude of about 4,000 feet and with a rather uniform slope to the east and southeast. The highest eleva-

tion reached is about 4,800 feet in the extreme northwest, while the southeastern border has an altitude of only 1,500 to 2,000 feet. East of the nearly level high plains is a rough, broken area where the cap rock is worn through and erosion is more rapid. Eastward still, below the cap rock, the country is rolling.

Drainage is eastward through the tributaries of several rivers, among them being, from north to south, the Cimarron, Canadian, Red, Pease, Brazos, and Colorado. In the high plains, above the cap rock, these streams tend to form canyons, the most notable being that of the Red River from Canyon, in Randall County, eastward for 60 miles.

## SOIL.

The soil varies from a light sand in some parts to a heavy clay or adobe in others. The clay soil predominates. The sandy soil is

FIG. 2.—Site of the Amarillo Cereal Field Station in 1905, before the experiments were begun.

covered with bunch grasses, while the clay soil is covered with buffalo, curly-mesquite, and blue-grama grasses. Figure 2, reproduced from a photograph of the site of the first experimental farm at Amarillo before work was begun, shows the nature of the country and the character of the vegetation on the clay-loam soil there. These soils are all quite fertile, judging from their power to produce crops when there is sufficient moisture. They are, however, very deficient in humus, owing to the scanty growth of the native vegetation. This lack of humus in the soil lessens its capacity to absorb and retain the moisture which falls upon it. It also leaves the soil

in a condition to become compact and to bake readily after heavy rains.

## CLIMATIC CONDITIONS.

No climatic data were available at Channing when the first experimental work was started there. The United States Weather Bureau has conducted an observatory at Amarillo since 1892, and there were disconnected records at two Army posts covering an earlier period. These records and a careful consideration of the native vegetation were of much value in choosing the general types of the various crops with which to begin work.

The principal climatic features of the Panhandle are a limited annual rainfall of irregular seasonal distribution with a great loss of water due to run-off during torrential showers, a relatively low atmospheric humidity, a high average wind velocity, a very high rate of evaporation, and violent fluctuations of temperature accompanied by cool nights in all the district except the lowest parts to the east and south.

### RAINFALL.

The average annual rainfall for the 20 years from 1892 to 1911, inclusive, at Amarillo is 21.41 inches, three-fourths of which comes during the growing season, from April to September, inclusive (Table I).

TABLE I.—*Monthly precipitation, in inches, at Amarillo, Tex., for the 20 years from 1892 to 1911, inclusive.*[1]

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual. | Mean annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1892 | 0.42 | 0.57 | 2.10 | 0.21 | 2.70 | 1.49 | 1.85 | 1.93 | 0.24 | 2.85 | 0.16 | 1.08 | 15.60 | ..... |
| 1893 | .09 | 2.03 | Trace. | .16 | 2.19 | 2.03 | 2.05 | 2.67 | 5.27 | .03 | .28 | .43 | 17.23 | 16.42 |
| 1894 | .02 | 1.15 | .05 | .85 | 1.30 | 3.59 | 1.82 | 3.41 | 2.41 | .39 | .00 | .82 | 15.81 | 16.21 |
| 1895 | 1.60 | 1.92 | .16 | 1.31 | 1.78 | 6.84 | 2.88 | 3.87 | .57 | 2.26 | .81 | .79 | 24.79 | 18.36 |
| 1896 | .76 | .41 | .21 | 1.95 | 2.20 | 2.31 | 7.04 | .63 | 2.45 | 3.09 | .35 | 2.88 | 24.28 | 19.54 |
| 1897 | 2.26 | .65 | .47 | 1.08 | 4.44 | 2.32 | 2.16 | 2.71 | .73 | 1.63 | .08 | .63 | 19.16 | 19.48 |
| 1898 | .86 | .82 | .35 | .98 | 3.52 | 4.81 | 3.88 | 4.03 | .48 | .41 | .34 | 2.06 | 22.55 | 19.91 |
| 1899 | .29 | .07 | .17 | .23 | 3.12 | 4.45 | 6.96 | .51 | 6.09 | 1.15 | 3.24 | 1.11 | 27.39 | 20.85 |
| 1900 | .59 | .47 | .48 | 5.47 | 4.53 | 1.94 | 3.21 | .83 | 5.25 | 1.58 | .08 | .07 | 24.40 | 21.24 |
| 1901 | .03 | .48 | .02 | 4.90 | 5.99 | .82 | 1.56 | 3.03 | 2.19 | 3.26 | 2.00 | .04 | 24.42 | 21.56 |
| 1902 | .04 | Trace. | .54 | 1.83 | 9.14 | 2.01 | 1.45 | 2.42 | .95 | 1.74 | 2.24 | .55 | 23.11 | 21.70 |
| 1903 | .12 | 2.93 | .26 | .90 | 1.79 | 2.83 | 3.38 | 4.67 | .82 | 2.58 | .00 | Trace. | 20.28 | 21.58 |
| 1904 | .16 | .08 | Trace. | .63 | 2.88 | 5.53 | 2.48 | 4.69 | 3.55 | .44 | .20 | .69 | 21.33 | 21.56 |
| 1905 | 1.00 | 1.52 | 2.62 | 4.52 | 6.16 | 2.19 | 3.76 | .63 | 3.08 | .30 | 5.09 | 1.45 | 32.32 | 22.33 |
| 1906 | .41 | .51 | .64 | 3.23 | 1.18 | 2.07 | 2.90 | 6.76 | 1.96 | 2.49 | 2.58 | .19 | 24.92 | 22.50 |
| 1907 | 1.11 | .24 | .02 | 1.25 | .99 | 1.97 | 1.49 | 6.20 | .91 | 1.79 | .66 | 1.46 | 18.09 | 22.19 |
| 1908 | .26 | .72 | Trace. | 1.90 | 3.55 | 1.73 | 5.40 | 2.75 | 1.83 | .40 | .51 | .00 | 19.05 | 22.04 |
| 1909 | .07 | .28 | 1.28 | .50 | 1.08 | 4.72 | 3.63 | .87 | 2.19 | 1.18 | 3.25 | .54 | 19.59 | 21.90 |
| 1910 | .05 | .17 | .34 | .59 | 2.99 | .66 | 3.57 | 2.19 | .05 | .26 | .28 | Trace. | 11.15 | 21.34 |
| 1911 | .13 | 2.88 | .50 | 2.76 | 5.88 | .20 | 3.85 | 2.97 | .83 | .84 | .94 | .95 | 22.73 | 21.41 |
| Average. | .51 | .89 | .51 | 1.76 | 3.37 | 2.73 | 3.27 | 2.89 | 2.09 | 1.43 | 1.15 | .78 | 21.41 | ..... |

[1] Data furnished by the observer of the U. S. Weather Bureau, Amarillo, Tex.

The seasonal rainfall is sometimes very irregular in its distribution, both as to time and locality. The monthly totals of rainfall often give a wrong idea of moisture conditions to a person unfamiliar with the country. The following not infrequent case will serve to illustrate: A heavy rain falls the first part of one month, the total quantity about equal to the average precipitation for that month. Then a period of drought follows, no rain falling for six or seven weeks, the drought finally being broken by heavy rains at the end of the second month, closely approximating the average for that month. Thus, the monthly averages show the normal rainfall, while in reality a severe drought has existed during the greater part of the period covered. This will be better understood by a close examination of the daily records in Table II.

TABLE II.—*Daily and monthly precipitation, in inches, at Amarillo, Tex., for the years 1905 to 1911, inclusive.*[1]

1905.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.10 | | 1.09 | | | | 0.09 | | Trace. | | |
| 2 | | .04 | Trace. | | | | | .21 | | Trace. | | Trace. |
| 3 | | .05 | | .38 | | | | | | | | |
| 4 | | .04 | | .22 | | | | | | | 1.01 | |
| 5 | | | | | 0.01 | | | | 0.64 | | | |
| 6 | | .36 | | | | Trace. | | .05 | | | | |
| 7 | | | 0.60 | | | 0.33 | Trace. | | .81 | | | |
| 8 | | | .10 | | Trace. | .88 | 0.41 | | .69 | | 1.84 | |
| 9 | 0.20 | | | | Trace. | | | | .94 | | 1.39 | |
| 10 | .40 | | .02 | | | | | | | | | |
| 11 | .34 | .04 | Trace. | Trace. | | | | .09 | | | Trace. | |
| 12 | .01 | .09 | Trace. | | | | | | | | | 0.97 |
| 13 | | | | | | .71 | | .15 | | | | .18 |
| 14 | .02 | | .30 | .10 | | | | | | | | |
| 15 | | | .40 | | | | | .03 | | | | |
| 16 | | | | | | | | | | | | |
| 17 | Trace. | .58 | .19 | | | | | | | 0.02 | | |
| 18 | | .22 | Trace. | .56 | .21 | | | | | | | |
| 19 | | | | | | | .56 | | | | | |
| 20 | | | .21 | | 1.00 | | .16 | | | | | |
| 21 | | | | | .46 | .19 | .86 | | | | .03 | .15 |
| 22 | | | | .12 | | .04 | .30 | | | | .54 | .15 |
| 23 | | Trace. | Trace. | 1.24 | .21 | .01 | 1.16 | | | Trace. | .24 | |
| 24 | .01 | | | .41 | .36 | | Trace. | | | .15 | | |
| 25 | | | | | | | Trace. | | | | | |
| 26 | | | | | 3.86 | | .18 | | | | | |
| 27 | | | | | .36 | | | | | Trace. | .01 | |
| 28 | | | | .35 | | | Trace. | | | | Trace. | |
| 29 | | | | .05 | | .03 | Trace. | | | | | |
| 30 | | | | | .02 | | .04 | | | .13 | | |
| 31 | .02 | | .80 | | .03 | | .09 | | | | | |
| Total | 1.00 | 1.52 | 2.62 | 4.52 | 6.52 | 2.19 | 3.76 | .63 | 3.08 | .30 | 5.09 | 1.45 |

[1] Data furnished by the observer of the U. S. Weather Bureau, Amarillo, Tex.

TABLE II.—*Daily and monthly precipitation, in inches, at Amarillo, Tex., for the years 1905 to 1911, inclusive*—Continued.

1906.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.16 | | | | | 0.01 | | | | | | 0.19 |
| 2 | .07 | | | | | .17 | 0.02 | 0.17 | 0.09 | | 0.02 | Trace. |
| 3 | .03 | | | 0.35 | | .84 | | Trace. | .94 | | | |
| 4 | .08 | Trace. | | .98 | | | | .11 | | | | |
| 5 | | | | | Trace. | | | | | 0.76 | | |
| 6 | | | | Trace. | 0.03 | | | | | | | |
| 7 | | | | .25 | Trace. | | Trace. | 4.05 | | | | |
| 8 | Trace. | | | | | | .50 | .37 | | | | |
| 9 | .05 | | | | | .35 | .09 | Trace. | | | | |
| 10 | .02 | | | | .04 | Trace. | .04 | .20 | | | | |
| 11 | | Trace. | Trace. | .07 | .53 | Trace. | .34 | | .04 | | | |
| 12 | | 0.50 | | .07 | Trace. | Trace. | .18 | | | | | |
| 13 | | .01 | | | Trace. | .42 | | | .01 | .22 | | |
| 14 | | | 0.02 | | .02 | | .15 | | .35 | .55 | | |
| 15 | | | | Trace. | .01 | | .07 | | | .02 | | |
| 16 | | | .04 | .45 | | | .61 | | | | | |
| 17 | | | | Trace. | | Trace. | .01 | | .06 | .02 | .03 | Trace. |
| 18 | | | | Trace. | | | Trace. | | .31 | | .68 | |
| 19 | | | | .68 | | | .14 | | | Trace. | .71 | |
| 20 | | | | | .01 | | | | | Trace. | .06 | |
| 21 | | | | | Trace. | | | | Trace. | .39 | | |
| 22 | | | .01 | | | | | | .19 | .53 | | |
| 23 | | | Trace. | | .54 | | | .21 | | | Trace. | |
| 24 | | | .13 | | | | .66 | .73 | | | Trace. | |
| 25 | | | .05 | | | | .06 | .92 | | | .23 | |
| 26 | | | | | | .28 | | .03 | | | | |
| 27 | | | .37 | | | | .04 | | | | Trace. | |
| 28 | | | .02 | Trace. | | | | | | | .45 | Trace. |
| 29 | | | | .38 | | | | | | | .27 | |
| 30 | | | | | | | Trace. | | | | .13 | |
| 31 | | | | | | | | | | | | |
| Total | .41 | .51 | .64 | 3.23 | 1.18 | 2.07 | 2.90 | 6.76 | 1.96 | 2.49 | 2.58 | .19 |

1907.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | 0.70 | 0.03 | | | | |
| 2 | | | | Trace. | Trace. | | .03 | 1.42 | | 0.02 | | |
| 3 | | Trace. | | | | 0.32 | | .14 | 0.21 | .65 | | |
| 4 | | | | 0.29 | | | | .19 | | | | |
| 5 | | | | Trace. | | | | | | | | |
| 6 | | | | | 0.02 | .05 | | | | | | |
| 7 | | | | | Trace. | | | | | .05 | | |
| 8 | 0.85 | | | | Trace. | | | | | | | |
| 9 | Trace. | | Trace. | | .34 | | | | .68 | | | |
| 10 | | | | | | | .41 | | | | 0.01 | |
| 11 | | | | | | | | | | | .02 | |
| 12 | .05 | | | | | Trace. | .01 | | | | | |
| 13 | | | | | Trace. | | | | | | | |
| 14 | | | | | .02 | Trace. | Trace. | | | | | |
| 15 | | | | | | | Trace. | | | | | |
| 16 | .03 | | | | | | Trace. | | | | | |
| 17 | Trace. | | | | | 1.27 | | | | | .01 | |
| 18 | .05 | | | | Trace. | .09 | | | | Trace. | .05 | |
| 19 | .01 | | | .04 | | | | .41 | .02 | .03 | .57 | |
| 20 | | | | .28 | | .24 | | .07 | | .07 | | |
| 21 | | | | .4 | | Trace. | | 1.47 | | .25 | | |
| 22 | | | | .04 | .03 | | | 2.30 | | | | |
| 23 | | | | | .05 | | | | | | | |
| 24 | .02 | | | | | Trace. | | | | .54 | | |
| 25 | .03 | | | | | | Trace. | | | .02 | | |
| 26 | .03 | | | | | | .26 | | | | | |
| 27 | | 0.24 | Trace. | | | | .04 | | | | | |
| 28 | | | 0.02 | | .14 | | .04 | | | .02 | | |
| 29 | | | | .11 | .17 | | | | | | | |
| 30 | .04 | | | .01 | .19 | | | .01 | Trace. | | | |
| 31 | | | | | .03 | | | .16 | | .14 | | |
| Total | 1.11 | .24 | .02 | 1.25 | .99 | 1.97 | 1.49 | 6.20 | .91 | 1.79 | .66 | |

TABLE II.—*Daily and monthly precipitation, in inches, at Amarillo, Tex., for the years 1905 to 1911, inclusive*—Continued.

1908.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | 1.07 | | 0.74 | | | |
| 2 | 0.02 | | | | | | | 0.82 | .05 | | | |
| 3 | .20 | 0.01 | | | | | | | | | | |
| 4 | | Trace. | | 0.01 | | | | | | 0.15 | | |
| 5 | Trace. | | | | | | | | | | | |
| 6 | | | | | | 0.42 | .01 | | | | | |
| 7 | | | | Trace. | | .34 | .18 | | | | | |
| 8 | | | Trace. | | | | | | | | | |
| 9 | | | | .15 | | Trace. | | | | | | |
| 10 | | .01 | | | | | | | | | | |
| 11 | | .10 | | Trace. | | | | Trace. | | | 0.01 | |
| 12 | | | | | | | Trace. | | | | .04 | |
| 13 | | .12 | | | | | .10 | .77 | | | Trace. | |
| 14 | | .48 | | | | | | Trace. | .23 | | | |
| 15 | .04 | | | .62 | | | | | | | | |
| 16 | | | | .09 | 0.46 | | | | .15 | | | |
| 17 | | | | | | | .54 | Trace. | | | | |
| 18 | | | | | | | .02 | | | Trace. | | |
| 19 | | | | 1.03 | | | .36 | | | .15 | | |
| 20 | | | | | | | | .11 | | | | |
| 21 | | | | | | | | Trace. | | | | |
| 22 | | | | | 1.81 | | | .48 | Trace. | .10 | | |
| 23 | | Trace. | | | 1.05 | | Trace. | | | | | |
| 24 | | | | | Trace. | .35 | | | | | | |
| 25 | | | | | | | | | .32 | | | |
| 26 | | | | | | | | .25 | .18 | | | |
| 27 | | | | | | Trace. | 1.13 | .32 | .16 | | .09 | |
| 28 | | | | | | .58 | | | | | .36 | |
| 29 | | | Trace. | Trace. | | | .04 | | | | .01 | |
| 30 | | | Trace. | | .19 | Trace. | .60 | | | | | |
| 31 | | | | | | | 1.35 | Trace. | | | | |
| Total | .26 | .72 | Trace. | 1.90 | 3.55 | 1.73 | 5.40 | 2.75 | 1.83 | .40 | .51 | |

1909.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Trace. | | | | | Trace. | 1.18 | | | | | |
| 2 | 0.01 | | | | | 0.10 | | | | | | |
| 3 | | | | | | | .02 | 0.10 | | | | 0.01 |
| 4 | | 0.02 | | | | | Trace. | .06 | 0.47 | | | .12 |
| 5 | | .02 | | | | | | .64 | .20 | | | |
| 6 | | | | | | Trace. | .67 | | Trace. | | | Trace. |
| 7 | | | | | | .20 | | .32 | 1.49 | | | |
| 8 | | | 0.07 | 0.07 | 0.04 | Trace. | .82 | Trace. | | 0.04 | | Trace. |
| 9 | | | | | | | .20 | .34 | | | | |
| 10 | Trace. | | | | | .20 | | | | | | |
| 11 | .06 | | .44 | | | .34 | | | | | | |
| 12 | | | .20 | Trace. | | .08 | | | 03 | | 0.99 | |
| 13 | | Trace. | | | | .88 | | Trace. | Trace. | | .12 | |
| 14 | | Trace. | | | | .18 | | Trace. | | | Trace. | Trace. |
| 15 | | | | | | .01 | .01 | .01 | | | .24 | |
| 16 | | | | | Trace. | Trace. | | | | | | |
| 17 | | | | | | | | | | .92 | | .36 |
| 18 | | .24 | | | | | | | Trace. | .21 | | .05 |
| 19 | | | Trace. | | .27 | | Trace. | Trace. | | .01 | | Trace. |
| 20 | | Trace. | | .18 | .60 | 1.08 | | Trace. | | | | |
| 21 | | | | .06 | | .34 | | | | | | |
| 22 | | | | .11 | .05 | Trace. | | | | | | Trace. |
| 23 | | Trace. | | Trace. | .03 | | | | | | | |
| 24 | | | Trace. | | .03 | .31 | | | | | | |
| 25 | | | | | | .65 | .10 | | | | | |
| 26 | | | | | | .25 | .63 | | | | | |
| 27 | | | | | .05 | | | | | | .57 | |
| 28 | | | | | | | | | | | .98 | |
| 29 | | | | | | | | | | | .35 | |
| 30 | | | .03 | .30 | .01 | .10 | | | | | | |
| 31 | | | .54 | | | | | | | | | |
| Total | .07 | .28 | 1.28 | .50 | 1.08 | 4.72 | 3.63 | .87 | 2.19 | 1.18 | 3.25 | .54 |

TABLE II.—*Daily and monthly precipitation, in inches, at Amarillo, Tex., for the years 1905 to 1911, inclusive*—Continued.

1910.

| Day. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | Trace. | 0.21 | | | | | |
| 2 | | Trace. | | | | | .01 | | Trace. | | | |
| 3 | Trace. | Trace. | | | 0.57 | | | 0.67 | | | | |
| 4 | 0.03 | | | 0.10 | .31 | | | | | | | |
| 5 | | | | | .02 | 0.01 | .05 | .02 | | | 0.27 | |
| 6 | | | | | | .02 | .07 | .18 | | | | |
| 7 | | | | | Trace. | | | | | | | |
| 8 | | | | | | | .32 | | | | | |
| 9 | | | | .22 | | | 2.05 | .64 | | | | |
| 10 | | | | | | | .02 | .18 | | | | |
| 11 | .01 | | | | | | | | Trace. | 0.02 | | |
| 12 | .01 | | | Trace. | | | | Trace. | | | | |
| 13 | | | | .26 | .26 | .02 | | | | | | |
| 14 | Trace. | | | Trace. | .03 | | | | Trace. | | .01 | Trace. |
| 15 | | | 0.06 | .01 | .77 | Trace. | | Trace. | | | | |
| 16 | | 0.17 | .15 | | | | | .19 | | | | |
| 17 | | | Trace. | | Trace. | | | .01 | | | | |
| 18 | | | | | .17 | | Trace. | Trace. | | | | |
| 19 | | | Trace. | | | | | | | .06 | | |
| 20 | | | | | | | | | | .18 | | Trace. |
| 21 | | | | | .60 | | | | | | | |
| 22 | | | | | .05 | .01 | | | Trace. | | | |
| 23 | | Trace. | | | .01 | | | | | | | |
| 24 | | | | | | Trace. | | .26 | 0.05 | | | |
| 25 | | | Trace. | | Trace. | .07 | | .02 | | | | |
| 26 | | Trace. | | | | .25 | | | | | | |
| 27 | | | | | .20 | | | | | | | |
| 28 | | | .13 | | | .28 | | | | | | Trace. |
| 29 | | | | | | | | | | | | |
| 30 | | | | | Trace. | | | | | | | |
| 31 | | | | | | | .84 | .02 | | | | Trace. |
| Total | .05 | .17 | .34 | .59 | 2.99 | .66 | 3.57 | 2.19 | .05 | .26 | .28 | Trace. |

1911.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.05 | | | | | | | 0.20 | | | 0.08 | |
| 2 | | | | Trace. | | | 0.01 | | | 0.13 | .33 | |
| 3 | | | | Trace. | | | Trace. | | | | Trace. | |
| 4 | | Trace. | | 0.01 | Trace. | | .01 | | | Trace. | Trace. | |
| 5 | | | | | | | | | Trace. | Trace. | .12 | |
| 6 | | | | | | Trace. | .32 | | | | | |
| 7 | | | | | | | .04 | | Trace. | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | 0.11 | .03 | | 0.13 | | | 0.01 |
| 10 | | 0.15 | | Trace. | | | | | | | | |
| 11 | | | | | | | .06 | | | | | |
| 12 | | | | | Trace. | | .32 | | | | | |
| 13 | | | | | 0.40 | | .42 | | | | | .02 |
| 14 | | | | | .15 | | Trace. | | | | | Trace. |
| 15 | Trace. | | | | .01 | | | | .41 | | | |
| 16 | | .46 | | | | | .03 | | | | | |
| 17 | .07 | 1.61 | | | | .08 | .50 | | | | | |
| 18 | | .22 | | | | | | | Trace. | | | .04 |
| 19 | | .15 | | | | | .68 | | Trace. | | | .76 |
| 20 | | | 0.40 | | .04 | | .47 | | .01 | .07 | | .07 |
| 21 | | Trace. | .10 | .04 | | | .49 | .07 | | Trace. | | |
| 22 | | | | | | | .12 | .66 | | | | |
| 23 | .01 | | | 2.61 | | | | 2.02 | | | | |
| 24 | | | | .07 | | | | | | | | |
| 25 | | | | .02 | | Trace. | | | | | | .02 |
| 26 | | | | .01 | .61 | | | | | .19 | .06 | Trace. |
| 27 | | .03 | | | | .01 | .16 | Trace. | | .17 | .35 | |
| 28 | Trace. | .26 | | | 1.64 | | .03 | .02 | | .14 | | |
| 29 | | | | | 2.90 | | .14 | | | .14 | | Trace. |
| 30 | | | | | .13 | | | | .28 | | | .03 |
| 31 | | | | | | | .02 | | | | | |
| Total | .13 | 2.88 | .50 | 2.76 | 5.88 | .20 | 3.85 | 2.97 | .83 | .84 | .94 | .95 |

Many of the rains during the summer are very local in character, consisting of heavy showers at different points with stretches of almost no rainfall between. To illustrate the variation in rainfall at near-by points, Table III gives a comparison of the rainfall at the United States Weather Bureau observatory and at the cereal testing station at Amarillo, Tex., for seven months during the growing period of 1909, the distance between the two points of observation being 2½ miles.

TABLE III.—*Comparison of the rainfall, in inches, at the United States Weather Bureau observatory and at the Amarillo Cereal Field Station, Amarillo, Tex., from March 1 to September 30, 1909.*

| Station. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Total. |
|---|---|---|---|---|---|---|---|---|
| United States Weather Bureau..... | 1.28 | 0.50 | 1.08 | 4.72 | 3.63 | 0.87 | 2.19 | 14.27 |
| Cereal Field Station..... | 1.08 | .27 | 1.13 | 5.90 | 2.19 | 1.39 | 1.90 | 13.86 |

FIG. 3.—View of a portion of the Amarillo Cereal Field Station after a torrential shower, August 22, 1907, showing the surface run-off which frequently occurs after such showers.

The rains usually are violent and last such a short time that much of the water is unable to get into the soil. For this reason there is a considerable run-off. The beating of the rain frequently makes the condition worse by puddling the surface and partially closing the pores. The run-off after a heavy rain is shown in figure 3.

## HUMIDITY.

The atmospheric humidity is, on the average, quite low and plays an important part in crop production.

### WIND.

The average hourly wind velocity for the years 1905 to 1910, inclusive, is 12 miles. For this same period there was an average of 13 days each year when the hourly wind velocity was over 40 miles. At times it reaches a much higher velocity. On March 24, 1909, it reached a maximum velocity of 63 miles. Great quantities of soil were carried by this wind; boxes, tin cans, nail kegs, clothing, etc., were scattered over the plats, and even some of the stakes marking the rows in the nursery were blown out of the ground. Great damage is done to crops by such high winds. The crops may be blown down, or they may be covered or cut by the moving particles of soil. For detailed data on wind, see Table V.

### EVAPORATION.

Evaporation of moisture from the ground and from the crops themselves is very great, reaching a maximum during periods of drought and high winds. The evaporation from the free water surface of a tank 8 feet in diameter reached a maximum of 0.69 inch in 24 hours in 1909.

During the seven months from March to September, inclusive, in 1909, when the observations recorded in Table IV were made at the farm, the evaporation from a free water surface was more than four times as much as the precipitation for the same period.

TABLE IV.—*Precipitation and evaporation, in inches, at the Amarillo Cereal Field Station, Amarillo, Tex., from Mar. 1 to Sept. 30, 1909.*

| Date. | Precipitation. | | Evaporation. | |
|---|---|---|---|---|
| | For dates given. | Total for month. | For dates given. | Total for month. |
| March: | | | | |
| 1 to 8 | 0 | | 1.575 | |
| 9 to 15 | .66 | | (1) | |
| 16 to 22 | 0 | 1.08 | 1.059 | 4.669 |
| 23 to 29 | Trace. | | 1.842 | |
| 30 to 31 | .42 | | .193 | |
| April: | | | | |
| 1 to 5 | 0 | | .978 | |
| 6 to 12 | Trace. | | 2.514 | |
| 13 to 19 | Trace. | .27 | 2.117 | 8.285 |
| 20 to 26 | .27 | | 1.103 | |
| 27 to 30 | Trace. | | 1.573 | |
| May: | | | | |
| 1 to 3 | 0 | | .718 | |
| 4 to 10 | .04 | | 2.514 | |
| 11 to 17 | 0 | 1.13 | 3.121 | 10.042 |
| 18 to 24 | .96 | | 1.403 | |
| 25 to 31 | .13 | | 2.286 | |
| June: | | | | |
| 1 to 7 | .12 | | 2.337 | |
| 8 to 14 | 1.98 | | 2.393 | |
| 15 to 21 | .98 | 5.90 | 2.500 | 10.296 |
| 22 to 28 | 1.94 | | 2.460 | |
| 29 to 30 | .88 | | .606 | |
| July: | | | | |
| 1 to 5 | 0.24 | | 1.134 | |
| 6 to 12 | 1.14 | | 2.010 | |
| 13 to 19 | Trace. | 2.19 | 2.484 | 10.075 |
| 20 to 26 | .70 | | 2.558 | |
| 27 to 31 | .11 | | 1.889 | |
| August: | | | | |
| 1 to 2 | 0 | | .712 | |
| 3 to 9 | 1.31 | | 2.416 | |
| 10 to 16 | .06 | 1.39 | 1.769 | 9.261 |
| 17 to 23 | .02 | | 2.120 | |
| 24 to 31 | 0 | | 1.611 | |
| | | | .633 | |
| September: | | | | |
| 1 to 5 | 1.88 | | 1.629 | |
| 6 to 12 | 1.88 | | 1.716 | |
| 13 to 19 | .02 | 3.78 | 1.716 | 8.411 |
| 20 to 26 | 0 | | 2.171 | |
| 27 to 30 | 0 | | 1.179 | |
| Total | | 15.74 | | 61.039 |

[1] Tank frozen over.

TEMPERATURE.

The highest temperatures have been much lower than might be expected when the altitude is not taken into consideration. The nights are nearly always cool. The average date of the last spring frost is April 18, and that of the first fall frost is October 28. The data on mean temperature, maximum and minimum temperatures, and greatest daily range by months for the years 1905 to 1911, inclusive, are given in Table V, which also presents data on precipitation, the condition of the sky, and the movement of the wind. The highest recorded temperature in the period covered by these records was 105° F., on June 25, 1912, and the lowest, −15° F., on February 13, 1905.

TABLE V.—*Climatic data recorded at Amarillo, Tex., for the years 1905 to 1911, inclusive.*[1]

1905.

| Month. | Temperature (° F.). | | | | | | | Precipitation (in inches). | | | | Sky (days). | | | | Wind. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Departure from the normal. | Highest. | | Lowest. | | Greatest daily range. | Total. | Departure from the normal. | Greatest in 24 hours. | Total snowfall, unmelted. | Rainy. | Clear. | Partly cloudy. | Cloudy. | Prevailing direction. | Movement (miles). | Number of days velocity 40 or more miles. |
| | | | Date. | Reading. | Date. | Reading. | | | | | | | | | | | | |
| Jan.. | 31.0 | − 0.9 | 30 | 67 | 13 | − 6 | 43 | 1.00 | +0.41 | 0.40 | 9.9 | 7 | 16 | 8 | 7 | NW. | 8,151 | 0 |
| Feb.. | 24.0 | −11.6 | 26 | 62 | 13 | −15 | 39 | 1.52 | + .56 | .58 | 18.7 | 9 | 8 | 11 | 9 | N. | 7,795 | 0 |
| Mar.. | 50.3 | + 4.3 | 27 | 78 | 8 | 28 | 41 | 2.62 | +2.23 | .80 | 5 | 8 | 15 | 10 | 6 | S. | 10,859 | 2 |
| Apr.. | 52.0 | − 3.0 | 27 | 82 | 15 | 28 | 34 | 4.52 | +2.73 | 1.24 | .6 | 10 | 19 | 7 | 4 | SE. | 9,512 | 2 |
| May . | 63.1 | − 1.0 | 8 | 87 | 4 | 42 | 39 | 6.52 | +2.73 | 3.86 | 0 | 10 | 26 | 4 | 1 | SE. | 10,103 | 4 |
| June. | 73.5 | + 2.0 | 28 | 94 | 21 | 56 | 27 | 2.19 | − .88 | .88 | 0 | 7 | 25 | 5 | 0 | S. | 9,559 | 0 |
| July . | 74.0 | − 1.0 | 12 | 94 | 9 | 51 | 36 | 3.76 | +1.22 | 1.16 | 0 | 9 | 21 | 5 | 5 | S. | 5,545 | 0 |
| Aug.. | 78.0 | + 3.0 | 16 | 98 | 9 | 60 | 34 | .63 | −2.09 | .30 | 0 | 6 | 25 | 6 | 0 | SE. | 8,001 | 0 |
| Sept. | 70.3 | + 2.0 | 1 | 96 | 19 | 44 | 34 | 3.08 | + .70 | .94 | 0 | 4 | 20 | 7 | 3 | S. | 8,594 | 2 |
| Oct.. | 55.0 | − 2.0 | 16 | 82 | 20 | 29 | 43 | .30 | −1.34 | .15 | 0 | 3 | 15 | 3 | 13 | S. | 8,124 | 0 |
| Nov.. | 46.8 | + .9 | 27 | 75 | 29 | 18 | 35 | 5.09 | +4.03 | 3.02 | 0 | 7 | 16 | 3 | 11 | SW. | 8,821 | 3 |
| Dec.. | 34.2 | − 2.1 | 8 | 60 | 1 | 33 | 38 | 1.45 | + .46 | 1.05 | 9.3 | 4 | 16 | 5 | 10 | NW. | 7,738 | 0 |
| 1906. | | | | | | | | | | | | | | | | | | |
| Jan.. | 38.8 | + 6.9 | 29 | 66 | 22 | 14 | 38 | 0.41 | −0.28 | 0.23 | 3 | 6 | 13 | 6 | 12 | SW. | 9,499 | 2 |
| Feb.. | 38.4 | + 2.8 | 21 | 74 | 5 | 6 | 46 | .51 | − .36 | .50 | .4 | 2 | 17 | 0 | 11 | SE. | 8,148 | 2 |
| Mar.. | 39.8 | − 5.1 | 25 | 74 | 19 | 12 | 54 | .64 | + .24 | .37 | .6 | 7 | 18 | 7 | 6 | NW. | 9,092 | 2 |
| Apr.. | 55.7 | + .4 | 23 | 82 | 4 | 31 | 40 | 3.23 | +1.52 | 1.33 | 0 | 8 | 16 | 11 | 3 | SE. | 9,516 | 1 |
| May . | 64.4 | + .2 | 31 | 90 | 7 | 38 | 38 | 1.18 | −2.00 | .57 | 0 | 7 | 22 | 4 | 5 | SE. | 9,112 | 0 |
| June. | 71.3 | − 1.1 | 30 | 100 | 4 | 50 | 42 | 2.07 | − .99 | .84 | 0 | 6 | 22 | 5 | 3 | SE. | 10,389 | 3 |
| July . | 73.6 | − 2.4 | 27 | 95 | 4 | 53 | 31 | 2.90 | − .44 | .72 | 0 | 14 | 18 | 5 | 8 | SE. | 6,588 | 0 |
| Aug.. | 73.4 | + .5 | 22 | 93 | 27 | 53 | 35 | 6.76 | +4.40 | 4.02 | 0 | 9 | 19 | 11 | 1 | SE. | 7,921 | 1 |
| Sept. | 69.0 | + 1.6 | 10 | 88 | 30 | 45 | 27 | 1.96 | − .61 | .94 | 0 | 8 | 21 | 8 | 1 | SE. | 7,659 | 0 |
| Oct.. | 53.4 | + 2.8 | 3 | 87 | 23 | 23 | 37 | 2.49 | + .83 | .55 | 9 | 7 | 18 | 6 | 7 | SE. | 9,032 | 0 |
| Nov.. | 41.1 | − 2.8 | 8 | 75 | 20 | 4 | 39 | 2.58 | +1.85 | 1.39 | 14.8 | 9 | 11 | 11 | 8 | SE. | 5,345 | 0 |
| Dec.. | 46.0 | + 9.7 | 3 | 74 | 16 | 25 | 37 | .19 | − .80 | .19 | T. | 1 | 19 | 8 | 4 | S. | 4,097 | 0 |
| 1907. | | | | | | | | | | | | | | | | | | |
| Jan.. | 52.4 | +10.5 | 5 | 74 | 25 | 15 | 46 | 1.11 | +0.42 | 0.85 | 0.9 | 9 | 15 | 12 | 4 | S. | 9,467 | 0 |
| Feb.. | 44.2 | + 8.6 | 8 | 74 | 3 | 7 | 42 | .24 | − .63 | .24 | .6 | 1 | 21 | 4 | 3 | S. | 7,789 | 1 |
| Mar.. | 56.8 | +11.8 | 19 | 96 | 1 | 20 | 46 | .02 | − .18 | .02 | 0 | 1 | 25 | 4 | 2 | S. | 10,039 | 2 |
| Apr.. | 52.6 | − 2.0 | 10 | 90 | 30 | 23 | 55 | 1.25 | − .46 | .52 | 8.3 | 7 | 18 | 8 | 4 | S. | 10,313 | 2 |
| May . | 59.0 | − 5.3 | 17 | 90 | 4 | 26 | 40 | .99 | −2.19 | .34 | 0 | 9 | 20 | 8 | 3 | NW. | 10,260 | 1 |
| June. | 71.6 | − .4 | 29 | 104 | 1 | 44 | 44 | 1.97 | −1.02 | 1.36 | 0 | 5 | 21 | 7 | 2 | S. | 9,585 | 1 |
| July . | 76.0 | − .1 | 24 | 99 | 1 | 55 | 36 | 1.49 | −1.68 | .73 | 0 | 7 | 21 | 9 | 1 | S. | 9,606 | 2 |
| Aug.. | 76.3 | + 1.7 | 15 | 97 | 31 | 58 | 35 | 6.20 | +3.39 | 2.38 | 0 | 10 | 16 | 11 | 4 | S. | 9,019 | 1 |
| Sept. | 70.8 | + 3.1 | 7 | 91 | 28 | 42 | 38 | .91 | −1.45 | .68 | 0 | 3 | 17 | 13 | 0 | S. | 8,503 | 1 |
| Oct.. | 57.6 | + 1.5 | 2 | 86 | 8 | 35 | 57 | 1.79 | + .80 | .65 | 0 | 10 | 10 | 12 | 9 | S. | 8,196 | 1 |
| Nov.. | 43.3 | − .5 | 6 | 74 | 12 | 16 | 38 | .66 | − .50 | .62 | 4 | 5 | 14 | 9 | 7 | S. | 6,725 | 0 |
| Dec.. | 38.3 | + 2.0 | 1 | 71 | 18 | 12 | 37 | 1.46 | + .63 | 1.46 | 1.4 | 2 | 15 | 11 | 5 | S. | 9,773 | 1 |

[1] Data furnished by the observer of the U. S. Weather Bureau, Amarillo, Tex.

TABLE V.—*Climatic data recorded at Amarillo, Tex., for the years 1905 to 1911, inclusive*—Continued.

1908.

| Month. | Temperature (° F). | | | | | | | Precipitation (in inches). | | | | Sky (days). | | | | Wind. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Departure from the normal. | Highest. | | Lowest. | | Greatest daily range. | Total. | Departure from the normal. | Greatest in 24 hours. | Total snowfall, unmelted. | Rainy. | Clear. | Partly cloudy. | Cloudy. | Prevailing direction. | Movement (miles). | Number of days velocity 40 or more miles |
| | | | Date. | Reading. | Date. | Reading. | | | | | | | | | | | | |
| Jan.. | 38.8 | + 4.9 | 9 | 70 | 16 | 7 | 44 | 0.26 | −0.35 | 0.22 | 0.4 | 3 | 18 | 10 | 3 | S. | 10,222 | 2 |
| Feb.. | 40.4 | + 3.2 | 28 | 77 | 1 | 4 | 43 | .72 | − .20 | .60 | 6 | 5 | 17 | 10 | 2 | NW. | 9,318 | 4 |
| Mar.. | 52.2 | + 7.2 | 17 | 86 | 9 | 20 | 48 | T. | − .65 | T. | T. | 0 | 23 | 6 | 2 | S. | 9,363 | 2 |
| Apr.. | 55.7 | + 1.1 | 14 | 80 | 2 | 29 | 38 | 1.90 | + .18 | 1.03 | 0 | 5 | 20 | 9 | 1 | S. | 9,093 | 2 |
| May . | 63.5 | − .8 | 19 | 91 | 7 | 34 | 43 | 3.55 | − .12 | 2.73 | 0 | 5 | 28 | 1 | 2 | SW. | 11,050 | 1 |
| June. | 73.3 | + 1.3 | 21 | 96 | 2 | 52 | 36 | 1.73 | −1.26 | .76 | 0 | 5 | 27 | 3 | 0 | S. | 11,011 | 2 |
| July . | 72.8 | − 3.3 | 11 | 96 | 7 | 55 | 31 | 5.40 | +2.23 | 1.95 | 0 | 11 | 16 | 13 | 2 | S. | 8,460 | 0 |
| Aug.. | 74.5 | − .1 | 10 | 97 | 8 | 58 | 33 | 2.75 | − .60 | .82 | 0 | 6 | 22 | 9 | 0 | S. | 7,891 | 0 |
| Sept . | 67.6 | − .1 | 6 | 97 | 28 | 36 | 35 | 1.83 | − .53 | .74 | 0 | 7 | 22 | 7 | 1 | S. | 7,259 | 0 |
| Oct.. | 56.7 | + .6 | 15 | 86 | 27 | 28 | 43 | .40 | −1.31 | .15 | 1 | 3 | 27 | 4 | 0 | S. | 9,812 | 2 |
| Nov . | 45.3 | + 1.5 | 17 | 78 | 14 | 11 | 46 | .51 | − .65 | .35 | 1.3 | 5 | 24 | 2 | 4 | NW. | 7,067 | 1 |
| Dec.. | 41.2 | + 4.8 | 16 | 72 | 19 | 18 | 41 | 0 | − .83 | 0 | 0 | 0 | 25 | 4 | 2 | S. | 8,337 | 0 |

1909.

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan.. | 41.0 | + 7.1 | 8 | 80 | 12 | 3 | 63 | 0.70 | −0.53 | 0.06 | 0.6 | 2 | 26 | 4 | 1 | S. | 10,167 | 2 |
| Feb.. | 41.6 | + 4.4 | 12 | 72 | 14 | 3 | 55 | .28 | − .60 | .24 | T. | 3 | 22 | 6 | 0 | S. | 10,264 | 4 |
| Mar.. | 44.9 | − .1 | 22 | 80 | 12 | 14 | 45 | 1.28 | + .63 | .57 | 12.5 | 5 | 21 | 8 | 2 | NW. | 9,545 | 2 |
| Apr.. | 54.0 | − 1.6 | 17 | 89 | 1 | 26 | 45 | .50 | −1.26 | .24 | 1.6 | 5 | 24 | 5 | 1 | S. | 10,794 | 4 |
| May . | 62.5 | − 1.8 | 28 | 93 | 1 | 27 | 45 | 1.08 | −2.59 | .85 | 0 | 8 | 21 | 9 | 1 | S. | 9,663 | 4 |
| June. | 73.5 | + 1.5 | 6 | 99 | 3 | 52 | 37 | 4.72 | +1.73 | 1.08 | 0 | 14 | 13 | 15 | 2 | S. | 9,003 | 2 |
| July . | 77.9 | + 1.8 | 11 | 96 | 1 | 62 | 30 | 3.63 | + .46 | 1.18 | 0 | 8 | 15 | 16 | 0 | S. | 8,270 | 0 |
| Aug.. | 78.0 | + 3.4 | 17 | 102 | 25 | 57 | 35 | .87 | −1.94 | .34 | 0 | 6 | 12 | 17 | 2 | S. | 7,599 | 0 |
| Sept . | 69.4 | + 1.7 | 2 | 95 | 23 | 45 | 40 | 2.19 | − .17 | 1.49 | 0 | 4 | 18 | 11 | 1 | S. | 7,906 | 0 |
| Oct.. | 57.9 | + 1.8 | 16 | 88 | 12 | 29 | 44 | 1.18 | − .53 | 1.13 | 0 | 4 | 20 | 7 | 4 | S. | 9,619 | 2 |
| Nov . | 50.4 | + 6.6 | 6 | 85 | 16 | 26 | 45 | 3.25 | +2.09 | 1.55 | 6.2 | 6 | 16 | 7 | 7 | S. | 8,456 | 0 |
| Dec.. | 31.0 | − 5.4 | 31 | 75 | 19 | 3 | 40 | .54 | − .29 | .41 | 5.3 | 4 | 15 | 10 | 6 | N. | 7,878 | 0 |

1910.

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan.. | 39.6 | + 5.7 | 1 | 76 | 5 | 9 | 40 | 0.05 | −0.55 | 0.03 | 0.3 | 3 | 10 | 15 | 6 | SW. | 8,483 | 0 |
| Feb.. | 35.6 | − 1.6 | 14 | 76 | 17 | − 4 | 44 | .17 | − .71 | .17 | 1.7 | 1 | 15 | 9 | 4 | N. | 8,981 | 0 |
| Mar.. | 56.5 | +11.0 | 25 | 87 | 10 | 31 | 48 | .34 | − .31 | .21 | 0 | 3 | 24 | 7 | 0 | S. | 9,183 | 4 |
| Apr.. | 58.5 | + 3.9 | 29 | 94 | 5 | 30 | 43 | .59 | −1.13 | .26 | 1.1 | 4 | 22 | 5 | 3 | NW. | 9,578 | 1 |
| May . | 61.6 | − 2.7 | 10 | 95 | 3 | 38 | 39 | 2.99 | − .68 | .79 | 0 | 11 | 10 | 15 | 6 | N. | 9,294 | 0 |
| June. | 75.9 | + 3.9 | 2 | 103 | 11 | 50 | 40 | .66 | −2.33 | .31 | 0 | 7 | 15 | 15 | 0 | S. | 9,629 | 0 |
| July . | 79.5 | + 3.4 | 8 | 100 | 1 | 58 | 37 | 3.57 | + .40 | 2.07 | 0 | 8 | 15 | 16 | 0 | S. | 8,330 | 1 |
| Aug.. | 76.3 | + 1.7 | 28 | 99 | 26 | 49 | 36 | 2.19 | − .62 | .72 | 0 | 10 | 18 | 13 | 0 | S. | 7,691 | 1 |
| Sept . | 73.8 | + 6.1 | 11 | 101 | 27 | 46 | 44 | .05 | −2.31 | .05 | 0 | 1 | 16 | 14 | 0 | S. | 8,694 | 0 |
| Oct.. | 60.4 | + 4.3 | 4 | 94 | 28 | 28 | 45 | .26 | −1.45 | .24 | 1.6 | 3 | 23 | 7 | 1 | S. | 8,306 | 0 |
| Nov . | 49.0 | + 5.0 | 12 | 82 | 30 | 24 | 39 | .28 | − .88 | .27 | 2.7 | 2 | 23 | 6 | 1 | S. | 7,642 | 0 |
| Dec.. | 39.8 | + 3.4 | 9 | 73 | 30 | 16 | 42 | T. | − .83 | T. | T. | 0 | 15 | 12 | 4 | S. | 8,155 | 0 |

1911.

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan.. | 45.6 | +11.7 | 31 | 82 | 3 | − 6 | 44 | 0.13 | −0.47 | 0.07 | 0.5 | 3 | 14 | 16 | 1 | SW. | 9,309 | .. |
| Feb.. | 38.6 | + 1.4 | 1 | 77 | 22 | 7 | 37 | 2.88 | +2.00 | 1.84 | 7.3 | 7 | 18 | 5 | 5 | SE. | 8,370 | .. |
| Mar.. | 51.4 | + 6.4 | 9 | 83 | 1 | 21 | 42 | .50 | − .15 | .50 | 0 | 2 | 25 | 6 | 0 | S. | 9,272 | .. |
| Apr.. | 56.8 | + 2.2 | 22 | 87 | 7 | 35 | 42 | 2.76 | +1.04 | 2.68 | 0 | 6 | 16 | 11 | 3 | S. | 9,732 | .. |
| May . | 65.6 | + 1.3 | 9 | 92 | 1 | 36 | 39 | 5.88 | +2.21 | 2.90 | 0 | 8 | 15 | 14 | 2 | SE. | 11,140 | .. |
| June. | 77.0 | + 5.0 | 25 | 105 | 4 | 59 | 35 | .20 | −2.79 | .11 | 0 | 3 | 21 | 9 | 0 | SE. | 8,544 | .. |
| July . | 75.4 | − .7 | 5 | 96 | 25 | 54 | 29 | 3.85 | + .68 | 1.15 | 0 | 18 | 7 | 19 | 5 | SE. | 7,160 | .. |
| Aug.. | 75.8 | + 1.2 | 6 | 102 | 28 | 54 | 38 | 2.97 | + .16 | 2.63 | 0 | 5 | 18 | 11 | 2 | SE. | 7,711 | .. |
| Sept . | 75.2 | + 7.5 | 5 | 95 | 19 | 54 | 36 | .83 | −1.53 | .41 | 0 | 4 | 16 | 13 | 1 | S. | 7,076 | .. |
| Oct.. | 57.1 | + 1.0 | 1 | 91 | 28 | 26 | 45 | .84 | − .87 | .34 | 3.1 | 6 | 18 | 8 | 5 | S. | 8,363 | .. |
| Nov . | 41.6 | − 2.2 | 16 | 75 | 29 | 5 | 57 | .94 | − .22 | .41 | 8.2 | 5 | 20 | 7 | 3 | SW. | 9,651 | .. |
| Dec.. | 30.1 | − 6.3 | 4 | 63 | 31 | 0 | 33 | .95 | + .12 | .83 | 9 | 8 | 18 | 8 | 5 | SW. | 6,792 | .. |

## EXPERIMENTAL WORK AT CHANNING.

### COOPERATIVE ARRANGEMENTS.

In the fall of 1903 arrangements were made with the Capitol Freehold Land & Investment Co., owners of large tracts in the Panhandle region of Texas, to conduct some cooperative experiments in cereal production on their large headquarters ranch, the XIT ranch at Channing. Under the agreement they were to provide the land and labor, and the Office of Cereal Investigations was to supply the seed and scientific assistance required. The experimental work was placed in charge of the junior writer. The land provided was 50 acres near the town of Channing, lying between the Fort Worth & Denver City Railway and the main road to the ranch from the town.

### PHYSICAL DATA FOR CHANNING.

The elevation of Channing is 3,900 feet, about 300 feet higher than Amarillo, which is about 50 miles distant. The deep valley or canyon of the Canadian River is between the two towns. The soil is lighter in texture than that around Amarillo and is classed as a sandy loam or sandy clay loam. The soil used in the experiments was rather thin, due probably to more than average erosion, as some small canyons tributary to the Canadian River head less than half a mile to the eastward.

The climatic conditions are very similar to those for Amarillo, though the rainfall probably averages a little lower and the effect of high winds is greater on the more sandy soils.

The rainfall data for the three years during which experiments were conducted are shown in Table VI.

TABLE VI.—*Monthly and annual precipitation, in inches, at Channing, Tex., during 1904, 1905, and 1906.*

| Month. | 1904 | 1905 | 1906 | Month. | 1904 | 1905 | 1906 |
|---|---|---|---|---|---|---|---|
| January | [1] 8.90 | 0.70 | 0.20 | August | 2.56 | 2.03 | 2.47 |
| February | | 1.20 | .56 | September | 4.05 | 5.65 | 2.57 |
| March | | 2.48 | .18 | October | 2.42 | .45 | 1.10 |
| April | | 5.52 | 3.26 | November | .25 | 4.86 | 1.55 |
| May | | 2.27 | 1.54 | December | .60 | .60 | 0 |
| June | | 1.35 | 0 | | | | |
| July | | 2.23 | 1.81 | Annual | 18.78 | 29.34 | 15.24 |

[1] Reliable U. S. Weather Bureau instruments were in use after July, 1904. The rainfall for 1904 previous to their installation was carefully measured, but the record was not kept by months.

### CROPPING CONDITIONS WHEN THE EXPERIMENTS WERE BEGUN.

The experimental work was greatly hindered at the beginning by the climate and cropping conditions at that time. The land had been broken from the sod in the spring of 1903, disk harrowed, and planted to milo with a lister. The growing crop received a drag harrowing and one cultivation. This crop was cut with a corn binder

and removed from the land. The experimental work was commenced October 20, 1903. As it was late and exceedingly dry, the land intended for fall seeding was not plowed but was double-disked instead and sown with a drill. A light rain in October moistened the surface soil and part of the seed germinated. As sufficient rain to cause germination and subsequent growth did not fall until April 28, 1904, the fall-sown small grains were a total failure, with the exception of a few individual plants.

All land intended for planting in the spring of 1904 was plowed during the previous dry autumn. As no rain fell until the latter part of April, the moisture supply was deficient, and germination of the spring grain took place irregularly throughout the month of May. With good summer preparation in 1903 the results would probably have been very different.

The preparation for the crop of 1905 was started in July, 1904. Later in that year a marked increase in the rainfall began and lasted for most of the year following. All plowing and tillage after the first year were thoroughly and promptly done, the desire being to put the soil in as good condition as possible, except in the special tillage operations.

## GENERAL PLAN OF PRELIMINARY EXPERIMENTS.

When the experimental work at Channing was commenced, the region was almost wholly used for cattle grazing. A few settlers were coming in and attempting to farm. Some of the ranchers also cultivated small fields. The crops which it was known would grow at all were limited, and there was little information as to suitable varieties of those supposed to be adapted to the locality. Therefore, at the start the work was of necessity very crude and elementary.

Some varieties of grain which were believed to be suitable for growing in the Panhandle region were planted in large plats, a few being as large as 4 or 5 acres each. It was hoped that some of these larger plantings would be successful, and thus adapted seed would be available for use and for distribution to farmers.

Many varieties of grains from all parts of the world were planted in small quantities. Most of these plantings were made in the cereal nursery, using only 1 ounce of seed of each variety. The seed of commercial varieties ordinarily obtainable is often a mixture of various strains, and much improvement usually can be effected by separating these strains, which are then grown and compared as if they were separate varieties. This kind of work seemed to be so necessary in many cases that where a commercial variety which was grown in a large plat proved to be much mixed it was sown in the nursery the next year and carefully purified before being again grown in the field.

In order to find varieties which might prove to be adapted to the conditions, 457 varieties of small grain were grown in a total of 912 tests during the three years in which experiments were conducted at Channing. Most of these varieties proved unfit and were discarded during the first two years. Only 31 of the most promising varieties were used in a total of 44 tests in 1906. All the varieties which were not extremely promising were omitted from the Channing tests that year, but were used in the work which was then begun at Amarillo, as were promising varieties of which only small quantities of seed were available. Yields are not reported in the Channing tests for plats smaller than one-tenth of an acre.

### VARIETAL EXPERIMENTS WITH WINTER GRAINS.

In the autumn of 1903 winter grains were seeded on an extensive scale at Channing. All varieties which were sown in field plats were failures. In the nursery some few spots were sufficiently moist to induce germination, but as there was no rain during the winter only a very few plants survived. The season of 1904 permitted quite good preparation for the planting of fall-sown small grains, and fairly good crops were obtained. The season of 1905–6 furnished the most favorable conditions which had yet occurred for preparation of the soil, and very good crops were again obtained, although the spring rainfall was deficient.

The tests of winter small grains furnished very dependable data on which to base the cultural and varietal experiments which were begun in 1906 on farm No. 1 at Amarillo, and also provided seed for use there. The results of these tests are shown in Table VII.

TABLE VII.—*Annual and average yields of varieties of winter small grains at Channing, Tex., for the years 1905 and 1906.*

| C. I. No.[1] | S. P. I. No.[2] | Name. | Original source. | Yield per acre (bushels). | | |
|---|---|---|---|---|---|---|
| | | | | 1905 | 1906 | Average. |
| | | WINTER WHEAT. | | | | |
| 2398 | 9872 | Galgalos | Russia | 18.16 | 23.40 | 20.78 |
| 2208 | 9125 | Kharkof | do | 16.71 | 24.50 | 20.60 |
| 1596 | 7582 | Fretes | Algeria | 18.00 | 20.60 | 19.30 |
| 2239 | 9358 | Beloglina | do | 12.93 | 23.50 | 18.21 |
| 2900 | ..... | Mixed wheat | Local | 20.00 | 16.00 | 18.00 |
| 2219 | 9129 | Padi | Russia | 13.47 | 10.93 | 12.20 |
| 2246 | 10364 | Kubanka[3] | do | 9.58 | 7.00 | 8.29 |
| 2100 | 13855 | Black Don[3] | do | ..... | 10.10 | ..... |
| 2227 | 9131 | Chul[4] | do | 6.85 | ..... | ..... |
| | | WINTER EMMER. | | | | |
| 2337 | 11650 | Black Winter | France | 51.20 | 31.20 | 41.20 |
| | | WINTER BARLEY. | | | | |
| 257 | 11193 | Tennessee Winter | Virginia | 11.40 | 32.50 | 21.95 |
| | | WINTER RYE. | | | | |
| 34 | 10367 | Ivanov | Russia | 19.10 | 16.50 | 17.80 |
| 114 | ..... | ..... | Kansas | 14.19 | 17.26 | 15.72 |
| 40 | 10366 | Abruzzes | Italy | 7.23 | ..... | ..... |

[1] Serial number of the Office of Cereal Investigations.
[2] Serial number of the Office of Foreign Seed and Plant Introduction.
[3] Spring durum wheat planted in the fall.
[4] Spring common wheat planted in the fall.

*Winter wheat.*—In the subsequent varietal tests at Amarillo all of the winter wheat varieties in Table VII were discarded except Kharkof and Beloglina, either because of lack of hardiness (in some

FIG. 4.—Field of fall-sown Fretes wheat (C. I. No. 1596) at Channing, Tex., in 1906.

years they have entirely winterkilled), or because of their low yield. The two varieties which have been retained, Kharkof (C. I. No. 2208) and Beloglina (C. I. No. 2239), are both hard red winter wheats from

FIG. 5.—Field of Black Winter emmer (C. I. No. 2337) at Channing, Tex., in 1905.

Russia. The three spring wheats which were tested for adaptability as winter sorts were conspicuously poor yielders in this test. A field of Fretes wheat at Channing in 1906 is shown in figure 4.

*Winter emmer.*—Emmer is a cereal closely related to wheat, but which retains its chaff. The variety here reported upon is probably of Russian origin. It weighs about 30 pounds per bushel and is quite hardy. It is of value only as a crop for feeding to live stock. A plat of this grain at Channing in 1905 is shown in figure 5.

*Winter barley.*—All varieties of barley which were tested at Channing produced very unsatisfactory yields. The Tennessee Winter variety was the only one tested in field plats.

*Winter rye.*—The two varieties which were tested each year did not yield as well as was expected. Further testing at Amarillo has reversed the position of these varieties in regard to yield.

### VARIETAL EXPERIMENTS WITH SPRING SMALL GRAINS.

In the autumn of 1903 plowing was done for the spring small-grain tests of 1904. This land was worked in very dry weather and spring seeding was done when there was no hope for immediate germination. Rains came so late that the tests were not at all typical of what can be secured under favorable conditions. The tests in 1905 and 1906 were made on well-tilled land. Many nursery tests with these grains were conducted in 1904 and 1905. These tests were continued at Amarillo, and many good strains from the nursery are now in the field tests. The yields from the spring small grains at Channing are given in Table VIII.

*Durum spring wheat.*—Owing to the necessity of purifying the varieties used in 1904 and 1905, the field tests were greatly restricted until pure strains of the best sorts could be selected and increased. Thus most of the tests reported in Table VIII are on the first year's crop only and the yields recorded are in no way conclusive.

*Common spring wheat.*—Three of the varieties reported in Table VIII have been continued at Amarillo and very valuable data obtained. Their yields are very close to those of the durums. It will be noted that these common wheats (with the exception of the Sonora, which was of little value) came from countries where durum wheats are commonly grown.

*Spring oats.*—The Burt oat, which has made the best yields (Table VIII), is an extremely early brown variety, prominent throughout the South. It resembles Red Rustproof in some characteristics, but it is earlier. The Sixty-Day is an early yellowish white variety, slightly later than the Burt.

*Spring barley.*—The data obtained from the tests of spring barley are shown in Table VIII. This crop has given uniformly poor yields at both Channing and Amarillo.

TABLE VIII.—*Annual and average yields of varieties of spring small grains at Channing, Tex., for the years 1904, 1905, and 1906.*

| C. I. No. | S. P. I. No. | Name. | Original source. | Yield per acre (bushels). | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1904 | 1905 | 1906 | Average for— | | |
| | | | | | | | 3 years. | 1904 and 1905. | 1905 and 1906. |
| | | DURUM WHEAT. | | | | | | | |
| 2088 | 7794 | Kahla | Algeria | 1.50 | | | | | |
| 2099 | 7792 | Mahmoudi | do | 2.00 | | | | | |
| 2222 | 8523 | Velvet Don | Russia | .50 | | | | | |
| 2247 | 9479 | do | do | .50 | | | | | |
| 2091 | 7428 | Albacete | Spain | 3.11 | 6.81 | 13.64 | 7.85 | 4.96 | 10.22 |
| 2934 | | | Algeria | 3.75 | 9.50 | | | 6.62 | |
| 1593 | 7578 | Marouani | do | 1.66 | 8.50 | | | 5.08 | |
| 1597 | 7579 | Medeah | do | | 9.41 | | | | |
| 2085 | 7585 | Black Poulard | do | | 7.00 | | | | |
| 2228 | 9130 | Saragolla | Italy | | 8.83 | | | | |
| 2235 | 9324 | Marouani | Algeria | | 10.83 | | | | |
| 2882 | 15788 | Kubanka | Russia | | 9.60 | | | | |
| 2941 | | | | | 8.26 | 14.21 | | | 11.23 |
| 2246 | 9478 | Kubanka | Russia | | 9.63 | 14.54 | | | 12.08 |
| 2246 | 10364 | do | do | | 9.00 | 15.00 | | | 12.00 |
| | | COMMON SPRING WHEAT. | | | | | | | |
| 1596 | 7582 | Fretes | Algeria | .83 | 4.85 | | | 2.84 | |
| 2398 | 9872 | Galgalos | Russia | 1.66 | 6.87 | 13.41 | 7.31 | 4.26 | 10.14 |
| 2227 | 9130 | Chul | do | | 7.84 | 15.33 | | | 11.58 |
| 2227 | 15802 | do | do | | 8.50 | | | | |
| 2940 | | Sonora | Colorado | | 4.58 | | | | |
| | | SPRING OATS. | | | | | | | |
| 293 | 11145 | Burt | Virginia | 1.56 | 25.78 | 26.40 | 17.91 | 13.67 | 26.09 |
| 458 | | Red Rustproof | | 4.67 | 19.55 | 24.25 | 16.15 | 12.11 | 21.90 |
| 165 | 5938 | Sixty-Day | Russia | 4.53 | 18.60 | 18.00 | 13.71 | 11.56 | 18.30 |
| 286 | 12133 | Red Algerian | Algeria | | 11.43 | | | | |
| 213 | 10330 | Swedish Select | Russia | 1.87 | 8.35 | | | 5.11 | |
| 254 | 8650 | North Finnish Black | Finland | 1.34 | 5.62 | | | 3.48 | |
| 451 | | Red Rustproof | Kansas | | | 17.64 | | | |
| | | SPRING BARLEY. | | | | | | | |
| 261 | 9877 | Mariout | Egypt | | 12.70 | | | | |
| 195 | 7969 | White Smyrna | Asia Minor | | 12.50 | | | | |
| 354 | 11192 | Manchuria | Ontario | | 8.49 | | | | |
| 226 | 9133 | Hanna | Austria | 1.50 | 5.67 | | | 3.58 | |
| 507 | 17525 | Boehme Hooded | Idaho | | | 8.45 | | | |

## RATE-OF-SEEDING TESTS WITH SMALL GRAINS.

In undertaking varietal experiments in a new region it is frequently a matter of much concern to know just how much seed to use in planting. The Channing experiments were based on the opinions of such ranchmen and farmers as could give information. Because of lack of seed of adapted varieties and of land for extensive tests, very few rate-of-seeding tests were conducted. Table IX shows the results obtained in these tests, which were too few and of too short duration to be conclusive.

TABLE IX.—*Annual and average yields obtained in rate-of-seeding tests with wheat and emmer at Channing, Tex., in 1905 and 1906.*

| C. I. No. | S. P. I. No. | Name. | Rate sown. | Yield per acre (bushels). | | |
|---|---|---|---|---|---|---|
| | | | | 1905 | 1906 | Average. |
| | | WINTER WHEAT. | *Pecks.* | | | |
| 2398 | 9872 | Galgalos | 3 | ..... | 23.40 | ..... |
| | | | 4 | ..... | 19.29 | ..... |
| | | WINTER EMMER. | | | | |
| | | | 6 | ..... | 31.20 | ..... |
| 2337 | 11650 | Black Winter | 7 | 51.20 | ..... | ..... |
| | | | 8 | 43.00 | 31.00 | 37.00 |
| | | SPRING WHEAT. | | | | |
| | | | 3 | 9.25 | ..... | ..... |
| | | | 4 | 10.83 | 13.91 | 12.37 |
| | | | 5 | 8.33 | ..... | ..... |
| 2246 | 10364 | Kubanka (durum) | 6 | 9.00 | 15.00 | 12.00 |
| | | | [1] 7 | 9.50 | ..... | ..... |
| | | | [1] 8 | 8.50 | 15.38 | 11.94 |
| | | | 4 | ..... | 15.33 | ..... |
| 2227 | 9131 | Chul (common) | 5 | ..... | 14.86 | ..... |
| | | | 12 | ..... | 13.23 | ..... |

[1] These plats showed a crowded stand and a poorer quality of grain both years.

## DATE-OF-SEEDING TESTS WITH WINTER WHEAT AND BARLEY.

Table X shows the results obtained in the date-of-seeding tests conducted with winter wheat and winter barley. They are, of course, quite too meager to be conclusive. An interesting feature of the date-of-seeding test of winter barley was the apparent effect of the date of planting on the presence of smut in the plats. The plat sown on September 21 contained 20 per cent of smut and that sown on October 7 contained 22.5 per cent, while no smut was found in the plat sown on November 28. The percentage of smutted heads was determined by actual counts of 1,000 heads in several parts of each plat.

TABLE X.— *Yields obtained in date-of-seeding tests with winter wheat and winter barley at Channing, Tex., in 1906.*

| Variety. | Date planted. | Date ripe. | Yield per acre (bushels). |
|---|---|---|---|
| Winter wheat: | | | |
| Padi | Sept. 12 | ..... | 10.18 |
| | Sept. 21 | ..... | 14.45 |
| Winter barley: | | | |
| Tennessee Winter | Sept. 21 | June 6 | 21.61 |
| | Oct. 7 | June 12 | 32.50 |
| | Nov. 28 | June 21 | 21.28 |

## FALLOWING AND CONTINUOUS CROPPING AS PREPARATION FOR WINTER WHEAT.

The results of preliminary experiments to compare the effects of alternate fallowing and of continuous cropping to wheat in the production of winter wheat are given in Table XI.

TABLE XI.—*Yields of winter wheat at Channing, Tex., in 1905 and 1906, from plats fallowed the previous year and plats continuously cropped.*

| Treatment. | Year, variety, and yield (bushels). | | | | |
|---|---|---|---|---|---|
| | 1905 | | 1906 | Total for 2 years. | Average. |
| | Padi. | Beloglina. | Kharkof. | | |
| Fallowed the previous year | 16.73 | 25.89 | | | |
| | | | 30.00 | 30.00 | 15.00 |
| Continuously cropped | 13.47 | | | | |
| | | 12.93 | 22.50 | 35.43 | 17.71 |
| Gain from fallowing | 3.26 | 12.96 | 7.50 | | |
| Gain by continuous cropping | | | | 5.43 | 2.71 |

The yields of 1905 are inconclusive, since there are no data of 1904 to compare with them. In 1906, however, the continuously cropped plat is the one occupied by Beloglina in 1905, and, its performance being known, comparison can be made, as shown in Table XI.

The tillage required in fallowing was almost as expensive as that in raising a crop; therefore definite conclusions would have to be based on the comparative expense of seed, planting, harvesting, etc., of two crops instead of only one.

### COMPARISON OF HOME-GROWN AND KANSAS-GROWN SEED OF SPRING OATS.

In 1906 Burt oats (C. I. No. 293, S. P. I. No. 11145), grown originally at McPherson, Kans., in 1903, and continuously at Channing since 1904, was compared with Burt oats (S. P. I. No. 15856) grown continuously at McPherson since 1903, from the same original seed. The home-grown seed yielded 26.4 bushels and the Kansas seed 13 bushels, a gain of 13.4 bushels in favor of home-grown seed in this test during a single season.

### SUMMARY OF YIELDS OF SMALL GRAINS.

A summary of the average yields of the different classes of small grains at Channing during 1905 and 1906 is given in Table XII.

TABLE XII.—*Average yields of small grains obtained at Channing, Tex., in 1905 and 1906.*

| Kind of grain. | Average yield per acre. | | Kind of grain. | Average yield per acre. | |
|---|---|---|---|---|---|
| | Bushels. | Pounds. | | Bushels. | Pounds. |
| White winter wheat (Galgalos) | 20.78 | 1,247 | Winter emmer | 41.20 | 1,030 |
| Hard red winter wheat | 20.60 | 1,236 | Winter barley | 21.95 | 1,054 |
| Durum spring wheat | 12.08 | 725 | Winter rye | 17.80 | 1,001 |
| Common spring wheat | 11.58 | 705 | Spring oats | 26.09 | 835 |

The Galgalos variety of white winter wheat reported in Table XII was afterwards discarded at Amarillo as a winter variety. It is still grown there as a spring wheat.

## VARIETAL EXPERIMENTS WITH CORN.

In general, the corn crops at Channing were very poor. The cool nights common to these elevated plains are not favorable to the growth of corn, nor does it stand well the severe droughts, which are not uncommon. The largest yield obtained was 35 bushels per acre. Counting each year's tests as separate, 105 varieties were grown during the three years and 131 tests were made.[1] Some of these trials were on a very small scale and of no importance. The results of field tests of varieties are shown in Table XIII. Unless otherwise noted, the yields recorded each year are the average of two plats grown in different portions of the field.

TABLE XIII.—*Annual and average yields of varieties of corn at Channing, Tex., in 1904 and 1905.*

| Name of variety. | Source of seed. | Yield per acre (bushels). | | |
|---|---|---|---|---|
| | | 1904 | 1905 | Average. |
| Channing Red | Local | 9.25 | 32.43 | 20.84 |
| Marlboro Prolific | South Carolina | 7.75 | 24.11 | 15.93 |
| Cocke's Prolific | Tennessee | 5.00 | 19.50 | 12.25 |
| Funk's Ninety-Day | Illinois | 6.75 | 13.25 | 10.00 |
| Leaming Yellow | Ohio | 6.50 | 5.82 | 6.16 |
| Pride of the North | Illinois | 3.25 | ..... | ..... |
| Boone County White | District of Columbia | 3.00 | ..... | ..... |
| McMackin's Gourdseed | ..... | 2.50 | ..... | ..... |
| U. S. P. B. No. 74 | District of Columbia | 2.17 | ..... | ..... |
| U. S. P. B. No. 77 | Ohio | 4.17 | ..... | ..... |
| Dakota Sunshine | North Dakota | ..... | .43 | ..... |
| Do | do | ..... | [1] 7.62 | ..... |
| Minnesota No. 13 | Minnesota | ..... | .50 | ..... |
| Do | do | ..... | [1] 10.39 | ..... |
| Sterling Yellow Dent | do | ..... | 2.33 | ..... |
| Do | do | ..... | [1] 8.24 | ..... |
| Ninety-Day Yellow Flint | Connecticut | ..... | .50 | ..... |
| Do | do | ..... | [1] 3.62 | ..... |
| Early Tuscarora | South Dakota | ..... | .70 | ..... |
| Do | do | ..... | [1] 5.87 | ..... |
| Leidigh's Yellow | Kansas | ..... | [2] 28.97 | ..... |
| Leidigh's White | do | ..... | [2] 24.40 | ..... |
| Leidigh's Leaming | do | ..... | [2] 19.59 | ..... |
| Hildreth's Yellow | do | ..... | 24.21 | ..... |
| Mexican June | Alabama | Failed. | ..... | ..... |
| Throckmorton's June | Local | ..... | [1] 22.00 | ..... |
| Alexander's White | do | ..... | [2] 23.70 | ..... |
| C. I. No. 92 | Illinois | ..... | [2] 13.11 | ..... |

[1] Yield of one plat planted on May 30. [2] Yield of one plat only.

The season of 1904 was very unfavorable for corn, opening with no moisture and continuing dry throughout. The varieties were all planted on April 12. The Channing Red, a local variety, and Marlboro Prolific kept in much better condition than the other sorts during the

[1] Acknowledgment is made to Mr. C. P. Hartley, of the Office of Corn Investigations, for 24 of the 105 lots of seed tested and for assistance in planning the corn tests.

growing period. The Mexican June corn also looked well, but did not mature any seed. The plantings of the Mexican June corn in later years were from home-grown or shorter season strains.

The season of 1905 was very moist, and the corn crop did well. The regular plantings were made on April 21. The varieties planted May 30 were early-maturing ones which it was thought might be suitable for late planting, except the June corn, which observation had shown to be a failure unless planted late. The crop of 1906, when five varieties were tested, was a failure, owing to the continued drought. Only the Channing Red, a local variety, produced grain. The yield of this variety was 6 bushels to the acre. It will be observed from the tests here reported that early northern types are not adapted and that long-season, late-maturing sorts have proved best.

When corn is compared with the grain sorghums, it will be seen how poor the corn yields really are. The 3-year average yield of the best variety of corn was 15.89 bushels to the acre, while the average yield of milo for the same period was 42 bushels. The available data on the comparative feeding value of corn and milo are limited. The lowest figure would make a bushel of milo 20 per cent less valuable than a bushel of corn, but ordinarily it is considered only 10 per cent less valuable.

## EXPERIMENTS WITH GRAIN SORGHUMS.

The grain sorghums are the standard on which all comparisons of cropping results in the Panhandle must be based, as they grow during the summer and fall when the most abundant rainfall is to be expected, and are adapted to use under the relatively high temperatures which occur during these months. In 1904, 4 varieties were tested; in 1905, 103 varieties were used in 125 tests; and in 1906, 24 varieties were planted. In 1906 the grain-sorghum nursery was planted at Amarillo, so only field plats were under test at Channing. These were cared for almost wholly by Mr. J. J. Edgerton, superintendent of the XIT farm. In 1905 the plantings of Red and Blackhull kafir were not comparable with those of milo, therefore complete 3-year averages are not obtainable. The 2-year averages may be regarded as reliable, as the results of the nursery tests of these varieties in 1905 are similar to the field-plat averages. The data obtained are given in Table XIV. Figure 6 shows a field of Blackhull kafir on the XIT ranch in 1906.

TABLE XIV.—*Annual and average yields of grain-sorghum varieties obtained at Channing, Tex., in 1904, 1905, and 1906.*

| Variety. | 1904 | | | 1905 | | | 1906 | | | Average of 1904 and 1906. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total crop. | Grain. | | Total crop. | Grain. | | Total crop. | Grain. | | Total crop. | Grain. | |
| | *Lbs.* | *Bus.* | *Lbs.* | *Lbs.* | *Bus.* | *Lbs.* | *Lbs.* | *Bus.* | *Lbs.* | *Lbs* | *Bus.* | *Lbs.* |
| Milo | 4,800 | 40 | 2,240 | 5,603 | 40 | 2,240 | 5,140 | 46 | 2,576 | 4,970 | 43 | 2,405 |
| Red kafir | 6,520 | 35 | 1,960 | ..... | ..... | ..... | 7,884 | 47 | 2,652 | 7,202 | 41 | 2,306 |
| Blackhull kafir | 5,875 | 31 | 1,736 | ..... | ..... | ..... | 6,874 | 35 | 1,994 | 6,374 | 33 | 1,865 |
| "Jerusalem corn" | 4,100 | 22 | 1,232 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Dagdi jowar | ..... | ..... | ..... | 8,408 | 40 | 2,240 | ..... | ..... | ..... | ..... | ..... | ..... |
| Edra durra | ..... | ..... | ..... | 4,488 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Milo-sumac cross | ..... | ..... | ..... | ..... | ..... | ..... | 11,480 | ..... | ..... | ..... | ..... | ..... |
| Milo-kafir cross | ..... | ..... | ..... | ..... | ..... | ..... | 7,022 | ..... | ..... | ..... | ..... | ..... |
| Shallu | ..... | ..... | ..... | ..... | ..... | ..... | 3,192 | 19.5 | 1,092 | ..... | ..... | ..... |

FIG. 6.—Field of Blackhull kafir on the XIT ranch at Channing, Tex., in 1906.

From 4 to 8 pounds of seed per acre were used in these tests, and a little thinning was done to obtain a uniform stand. It will be noted that in the tabulated data the yields of the grain are given in pounds to the acre, as well as in bushels. The different varieties of grain sorghums in the area under consideration vary in test weight per measured bushel. The thrashing machinery cuts or cracks a considerable portion of the grain and removes the glumes to a greater or less extent. As the cracking and hulling varies with different machines, varieties, and conditions of moisture, results given in bushels

of a certain weight are somewhat misleading. The grain is treated commercially like corn, oats, mill feeds, etc., in that region, being handled either in bulk or sacked and sold in units of 100 pounds. Prices for these grains are almost invariably quoted by the hundredweight, rarely by the bushel. The value is therefore based on the total weight irrespective of the weight per bushel.

Milo, which was the only variety of grain sorghum grown in field plats all three years, produced an average of 42 bushels, or 2,350 pounds of grain for the period. It also produced a higher average yield for the two years, 1904 and 1906, than either Red or Blackhull kafir.

### EXPERIMENTS WITH MILO.

In 1903 the junior writer devoted considerable time to travel, observing crops and cropping conditions. The good qualities of milo as a field crop were very evident in the Panhandle, and comprehensive tests were planned. Fairly uniform strains were found and many field tests were made in 1905, while other varieties were being purified in the nursery. Table XV shows the results of the rate-of-planting tests with this crop. The lack of uniformity in the results of various years is due largely to differences in quality of seed and the seasonal influences on germination. It should be added that the spring condition of the soil in both 1905 and 1906 was very good and that later tests at Amarillo have seemed to justify thinner seeding than here shown, probably because of drier seasons.

TABLE XV.—*Yields of milo obtained from thick, medium, and thin planting at Channing, Tex., in 1904, 1905, and 1906.*

| Relative stand. | Distance between plants in 42-inch rows. | Yield per acre. | | |
|---|---|---|---|---|
| | | Total crop. | Grain. | |
| | *Inches.* | *Pounds.* | *Pounds.* | *Bushels.* |
| Crop of 1904: | | | | |
| Thick | 4 | 4,800 | 2,240 | 40 |
| Crop of 1905: | | | | |
| Thick | 4.25 | 5,603 | 2,240 | 40 |
| Do | 5 | 4,331 | 1,792 | 32 |
| Medium | 12 | 4,399 | 1,512 | 27 |
| Thin | 15 | 5,320 | 1,904 | 34 |
| Do | 15 | 4,501 | 1,736 | 31 |
| Do | 17 | 4,875 | 1,680 | 30 |
| Crop of 1906: | | | | |
| Thick | 6.9 | 4,551 | 1,567 | 28 |
| Do | 7.3 | 5,278 | 1,759 | 31 |
| Do | 8.7 | 5,278 | 1,602 | 28 |
| Medium | 10.4 | 4,906 | 1,398 | 25 |

Miscellaneous tests with milo are shown in Table XVI. These include a date-of-planting test and data on the first tests of selected seed from erect-headed plants, also a test of noncultivated compared with cultivated milo.

TABLE XVI.— *Yields of fodder and grain obtained in miscellaneous tests of milo at Channing, Tex., in 1905.*

| Description of test. | Yield per acre. | | |
|---|---|---|---|
| | Total crop. | Grain. | |
| | *Pounds.* | *Bushels.* | *Pounds.* |
| Planted thick, Apr. 26 | 4,402 | 31 | 1,736 |
| Planted thick, May 17 | 5,140 | 46 | 2,570 |
| Selection from pendent-headed plants, thick stand | 4,880 | 35 | 1,960 |
| Selection from erect-headed plants, thick stand | 3,540 | 26 | 1,456 |
| Planted late with grain drill, 2 pecks per acre | 4,690 | 41 | 2,296 |
| Planted late in rows and cultivated | 5,371 | 37 | 2,072 |

EXPERIMENTS WITH KAFIR.

Kafir has been grown in the Panhandle to a small extent since its first distribution by the Department. Preliminary observations showed that the kafirs generally were late in maturing and were also badly hybridized with sorgos or sweet sorghums; therefore attention was devoted in 1905 to obtaining pure strains rather than to yield tests. A rate-of-planting test with the selected seed was conducted in 1906, the results of which are given in Table XVII.

TABLE XVII.— *Yields of fodder and grain obtained from different rates of planting Blackhull kafir at Channing, Tex., in 1906.*

| Distance between plants in 42-inch row. | Yield per acre. | | |
|---|---|---|---|
| | Total crop. | Grain. | |
| *Inches.* | *Pounds.* | *Bushels.* | *Pounds.* |
| 2.2 | 6,874 | 35 | 1,994 |
| 3.2 | 5,992 | 33 | 1,899 |
| 4 | 5,690 | 29 | 1,641 |
| 5.6 | 6,549 | 31 | 1,733 |
| 6 | 6,686 | 30 | 1,719 |

VARIETAL TESTS OF PROSO, OR RUSSIAN GRAIN MILLET.

Proso is a grain crop which includes certain varieties of the so-called panicled or broom-corn millet (*Panicum miliaceum*). It may have some importance as a catch crop in the Panhandle region. It grows rapidly and can be utilized as a feed for chickens, sheep, or hogs, in addition to the uses which are ordinarily made of the crops of the region. The seed is not readily available locally. Planting is done the latter part of May, using 20 pounds of seed to the acre. The yields obtained at Channing are given in Table XVIII.

TABLE XVIII.— *Yields of proso obtained at Channing, Tex., in 1904 and 1905.*

| C. I. No. | S. P. I. No. | Variety. | Yield per acre (bushels). | | |
|---|---|---|---|---|---|
| | | | 1904 | 1905 | 2-year average. |
| 21 | 9423 | Red Orenburg | 5.53 | ..... | ..... |
| 21 | 9423 | .....do | 5.58 | ..... | ..... |
| 26 | 9424 | Red Voronezh | 8.20 | ..... | ..... |
| 27 | 9425 | Black Voronezh | 10.00 | 19.63 | 14.81 |

No experiments with proso were conducted at Channing in 1906. In 1904 and 1905 a total of 19 varieties were grown in 39 tests.

## EXPERIMENTAL WORK AT AMARILLO.

### CLIMATIC AND SOIL CONDITIONS.

The city of Amarillo is located in latitude 35° 12′ N. and longitude 101° 51′ W., at an altitude of 3,676 feet. The climatic conditions, which are fairly representative of the Panhandle region as a whole, have already been fully discussed. As will be noted, nearly all the climatic data presented in this bulletin were obtained from the records of the United States Weather Bureau at Amarillo.

The soil is a chocolate-colored clay. It is locally known as "tight" or "short-grass" land and is covered with a mixed sod of buffalo grass and blue grama, with a small proportion of other grasses. This chocolate-colored soil is from 3 to 5 feet deep, with a reddish clay subsoil. The depth to water is from 200 to 300 feet. Figure 2 (p. 13) gives a general idea of the surface condition of the unbroken land.

### THE FIRST FARM.

The farm on which the experimental work was first established at Amarillo consisted of 100 acres of practically level land lying only one-fourth mile distant from the city limits, on the southwest side. The land and permanent equipment were furnished by the Amarillo Chamber of Commerce and held under annual lease renewable at option for a period of five years. In addition to the land, a two-story building was provided for use as an office, laboratory, and seed house combined. Later, a small implement shed was provided. No house, barn, or well was supplied on this farm.

The land was fairly well adapted for experimental purposes, except that it was badly cut by old roads and trails dating from the day of unfenced lands under the range system, as shown in figure 2.

### THE PRESENT FARM.

The new farm consists of 120 acres of level, short-grass land lying about 2 miles northeast of the town and about 4 miles distant from the first farm. The northern boundary is a well-traveled public road, while the southern boundary is an oblique line formed by the right of way of the Atchison, Topeka & Santa Fe Railway. A few rods farther south is the Chicago, Rock Island & Gulf Railway, while the tracks of the Fort Worth & Denver City Railway are about three-fourths of a mile distant in the same direction.

This farm and its equipment are provided by the Amarillo Chamber of Commerce, by which organization it is leased to the Department of Agriculture for a term of 15 years with an option by the Department of extending the lease for the further term of 5 years, if desired. The equipment consists of a good dwelling house, barn, seed house and laboratory, well, windmill and tank, and fence. The principal buildings and a portion of the farm are shown in figure 7.

This farm was made available in 1908 and the experimental work thereon was begun with the planting of winter grains in the fall of 1909. Owing to the fact that the farms are less than 4 miles apart and that soil and other environmental conditions are practically identical, the transfer of the experiments from one location to the other does not break their continuity.

### SYSTEM OF UNIFORM PLATS.

Both the farms at Amarillo were divided into uniform plats of one-tenth acre each, being 50 by 200 links or 2 by 8 rods in size. Roadways 30 links or 19.8 feet wide at the ends of the plats and alleys 7 links or 4.62 feet wide separate the plats from one another. By using this system, the crop, variety, yield, etc., of each plat for any year are definitely known and error or confusion is less probable. The use of plats of equal size in the tests makes uniform the effect of the surplus feeding area which is available around the edge of the plat, and which certainly varies where plats of different sizes or shapes are used. The surplus feeding area influences comparisons of yield per acre on nonuniform plats even where careful surveying is done. General views of the plats on the two Amarillo farms are shown in figures 8 and 9.

### ENLARGED FACILITIES AND COOPERATION.

With the transfer of the work from Channing to Amarillo, which was begun in the fall of 1905 and completed during the summer of 1906, the facilities for conducting the work were greatly enlarged.

The farm at Amarillo contained double the area used in the experiments at Channing. Better machinery was added from time to time, more help was available, and the work as a whole was made more permanent. Up to the time of this transfer the Office of Cereal Investigations had conducted all the experiments. As the work grew, other offices in the Bureau of Plant Industry became interested

FIG. 7.—General view of the buildings on the new farm of the Amarillo Cereal Field Station, Amarillo, Tex.

and it was but a short time until various cooperative experiments were instituted.

Most of the cultivation and rotation experiments which had been started were transferred at this time to the Office of Dry-Land Agriculture, and a large series of very definite experiments was inaugurated. The general plan of the work is to determine the effect of con-

FIG. 8.—View of a portion of the plats on the farm first occupied by the Amarillo Cereal Field Station, Amarillo, Tex.

tinuous cropping and summer fallowing by various methods of farming, and to conduct rotations which are not necessarily practical but which bring out the residual effect of preceding crops and of cultivation. A study of the influence of fall and spring plowing on crop yields is also included. The Office of Dry-Land Agriculture furnished a man to be in direct charge of their experiments.

The Office of Biophysical Investigations installed a number of instruments for obtaining meteorological data and making soil moisture determinations in connection with crop production. This work is very closely associated with that of the Office of Dry-Land Agriculture. The offices of Forage-Crop Investigations, Sugar-Plant Investigations, Corn Investigations, and Field Investigations in Pomology also have conducted cooperative work with the Office of Cereal Investigations at Amarillo. The last line of cooperative work inaugurated was with the Office of Field Investigations in Pomology in determining suitable varieties of fruit trees for the Panhandle region. A few apple, crab apple, plum, and cherry trees were set in the spring of 1911 and the area has since been considerably increased. The work with alfalfa and sugar beets has been discontinued by the

FIG. 9.—General view of the small-grain nursery and field plats on farm No. 2 occupied by the Amarillo Cereal Field Station, Amarillo, Tex.

offices having charge of those crops. All these cooperating offices have allotted funds in support of the work conducted by them.

In addition to the work at Amarillo, the Office of Cereal Investigations has conducted some experiments with grains at Chillicothe, Tex., in cooperation with the Office of Forage-Crop Investigations, and also at Dalhart, Tex., with the Office of Dry-Land Agriculture. The results of the experiments at these two places are given separately after the report on the Amarillo work.

## SCOPE AND EXTENT OF THE EXPERIMENTS.

The work at Amarillo was quite extensive for the year 1906, although that was the first crop year. The soil was indifferently prepared and therefore very difficult to cultivate. The larger proportion of the experiments were varietal tests of the different cereals. There were some rate-of-seeding and date-of-seeding tests and some cultivation

experiments. There were 329 crop tests in field plats and 1,186 tests in nursery rows. In addition to these, 109 plats were used by the Office of Dry-Land Agriculture. Though quite large, the number of varieties grown was much smaller than the number of tests made.

The scope of the work has gradually broadened with the passing of the years. Lines of work that have given most promise of success have been increased. The grain sorghums now rank first in the space required for experimentation as well as in the yields of grain. New varieties are being tested and the better varieties are being improved by selection and breeding. This is true not only of the sorghums but of all the cereals now grown. More attention is given to rates and dates of seeding, time and depth of plowing, and subsequent cultivation.

Permanent environmental experiments have been inaugurated. These are known as trilocal experiments and are now conducted with winter wheat, oats, milo, kafir, and Sudan durra. The object of these experiments is to determine the change in chemical composition due to environment, and incidentally to test the value of home-grown seed in comparison with that grown at some distant place.

During the year 1911 there were 380 crop tests in field plats and 1,451 tests in nursery rows, besides the 123 tenth-acre plats used in permanent experiments for the Office of Dry-Land Agriculture.

## NURSERY TESTS WITH SMALL GRAINS.

The detailed results from the nursery work are not given in this bulletin. It may be well, however, to outline briefly the system under which this part of the work is done, which is as follows:

Series A consists of short rows, each grown from an individual selected head. These are planted by hand. New varieties, introductions, local sorts, etc., are generally grown in small plats, and heads are selected from these plats and grown in head rows in series A; or head selections may be made from plats of varieties already being tested on the farm. Series A plantings of small grains at Amarillo in 1909 are shown in figure 10, with some of the larger plantings in the background.

Series B consists of rows of definite length (15 feet) planted with bulk seed from the rows in series A by means of a garden drill. This is the second generation from selected individual heads. From these rows comparative yield tests are obtained. The poorer sorts are continued in series B another year or are discarded, while the better ones are carried forward to series C.

Series C consists of two rows, each 2 rods long, planted by means of a garden drill with bulk seed from the better rows of the B plantings of the previous year. Comparative tests are obtained. The poorer strains are given another trial in the same series or are discarded. The better ones are carried forward to series D.

Series D consists of increase plats grown from seed of the best strains in series C and planted with an ordinary grain drill. Comparative tests are again obtained, as

well as fairly accurate acre yields. The seed from desirable strains in series D is sufficient to permit testing the grain in field plats.

Series E consists of field plats of varying size, usually one-tenth acre each, planted with a grain drill with seed from the plats in series D.

Very careful detailed agronomic notes are taken on all these eries, especially on series A, B, and C.

## VARIETAL EXPERIMENTS WITH WINTER CEREALS.

The yields of the winter cereals at Amarillo from 1906 to 1911, inclusive, are given in Table XIX. It will be noted that the crop of 1906 was uniformly good. The fall of 1905 was very wet and there continued to be plenty of moisture during the winter and spring of 1906. The crop of 1907 was grown under more severe climatic conditions, but in spite of this fact gave promise of making good

FIG. 10.—The small-grain nursery and a portion of the experimental plats of the Amarillo Cereal Field Station, Amarillo, Tex., in 1909.

yields until it was cut short by a severe hailstorm on June 3. The hail damage was estimated at 75 per cent. Actual yields, however, were used in the table and in computing averages. The crop of 1908 was checked in its growth by a severe drought in the spring, but fairly good yields were obtained. In 1909 the crop was almost a total failure. The seed germinated in the fall, but there was not enough moisture in the soil to carry the plants through the dry winter and spring. The 1910 crop was raised under conditions quite similar to those of 1909, though somewhat less severe. The almost total failure of the 1911 crop was due to the fact that there was not enough moisture in the soil to germinate the seed until late in February and a very severe drought in June killed a large proportion of the plants.

TABLE XIX.—*Annual and average yields of winter small grains in field plats at Amarillo, Tex., for the six years from 1906 to 1911, inclusive.*

| C. I. No. | S. P. I. No. | Kind of grain. Name. | Description. | Source. | Yield of grain per acre (bushels). 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WHEAT. | | | | | | | | | |
| 1558 | 11610 | Turkey | Hard red | Russia | 25.75 | 3.26 | 23.23 | 0 | 10.17 | 1.58 | 10.66 |
| 1395–2 | ..... | Diehl Mediterranean. | Medium hard red | Kansas | 18.50 | 1.41 | 25.83 | 0 | 10.42 | .38 | 9.42 |
| 1667 | 7787 | Beloglina | Hard red | Russia | 24.25 | 3.77 | 14.33 | 0 | 10.88 | 1.88 | 9.18 |
| 2208 | 9125 | Kharkof | do | do | 21.92 | 2.75 | 14.33 | [1] 2.83 | 8.38 | 1.58 | 8.63 |
| 1436 | 5635 | Crimean | do | do | 17.62 | 2.66 | 17.00 | 0 | 7.00 | 2.13 | 7.73 |
| 1561 | 5497 | Theiss | do | Hungary | 24.91 | 1.70 | 8.16 | 0 | 7.96 | 2.15 | 7.48 |
| 1564 | 5500 | Pesterboden | do | do | 25.20 | 1.70 | 7.83 | 0 | 7.96 | 1.83 | 7.42 |
| 1437 | 5636 | Crimean | do | Russia | 20.95 | 3.00 | [2] 0 | 0 | 10.38 | 2.00 | 7.26 |
| 2239 | 9358 | Beloglina | do | do | 20.09 | 3.60 | 9.10 | 0 | 8.64 | 2.17 | 7.26 |
| 1563 | 5499 | Weissenberg | do | do | 21.00 | 4.34 | 9.18 | 0 | 7.21 | 1.67 | 7.23 |
| 2900–2 | ..... | Mediterranean | Medium hard red | Central Texas. | 21.91 | 1.74 | 11.09 | 0 | 4.71 | [4] | 7.89 |
| [3] 1596 | 7582 | Fretes | do | Algeria | 19.37 | [5] 1.41 | 12.83 | 0 | 0 | [6] | 6.72 |
| 2398 | 9872 | Galgalos | Medium hard white. | Russia | 20.36 | 0 | 9.00 | 0 | 2.88 | [6] | 6.45 |
| 2902 | ..... | Mammoth Red | Hard red | Texas | ..... | 2.90 | 21.00 | 7.55 | 7.00 | 3.29 | 8.35 |
| 2223 | 11229 | Turkey | do | Russia | ..... | 2.90 | 23.08 | 0 | 10.92 | 1.92 | 7.76 |
| 2942 | 17994 | Rieti | Medium hard red | Italy | ..... | 4.61 | 14.88 | 0 | 5.38 | 6.79 | 6.33 |
| 2092 | 7430 | Jejar | Hard red | Spain | ..... | [7] 2.77 | 21.66 | 0 | 0 | ..... | 6.11 |
| 2900–1 | ..... | ..... | do | ..... | ..... | 1.95 | 5.83 | 6.66 | 6.58 | ..... | 5.25 |
| 2901 | ..... | Mediterranean | Medium hard red | Texas | ..... | 2.90 | 14.66 | 0 | ..... | ..... | 5.85 |
| 2903 | ..... | White-chaff Mediterranean. | do | do | ..... | 2.90 | ..... | ..... | ..... | ..... | ..... |
| 2943 | ..... | ..... | do | do | ..... | 4.53 | ..... | ..... | ..... | ..... | ..... |
| | | SPELT.[8] | | | | | | | | | |
| 1772 | ..... | Red Winter | ..... | Washington. | 49.68 | 14.39 | 50.38 | 0 | 15.20 | 20.80 | 25.07 |
| | | EMMER.[8] | | | | | | | | | |
| 2337 | ..... | Black Winter | ..... | France | 45.43 | 8.07 | 30.75 | 0 | 24.10 | 9.50 | 19.64 |
| 2483–2 | ..... | do | ..... | Germany. | ..... | 13.59 | 22.82 | 2.79 | 23.30 | 9.00 | 14.30 |
| | | BARLEY. | | | | | | | | | |
| 257 | ..... | Tennessee | ..... | Tennessee. | 23.93 | 0 | 22.49 | 0 | 3.13 | 14.11 | 10.61 |
| | | RYE. | | | | | | | | | |
| 114 | ..... | Kansas | ..... | Kansas | 20.89 | 1.58 | 15.66 | 5.00 | 6.43 | 4.87 | 9.07 |
| 34 | ..... | Ivanov | ..... | Russia | 19.37 | .63 | 13.66 | 2.66 | 4.82 | 4.82 | 7.66 |
| | | OATS. | | | | | | | | | |
| 274 | 16864 | Snoma | Brown | West Virginia. | ..... | 4.03 | 15.31 | 0 | 0 | ..... | 4.83 |
| 273 | 12878 | Culberson | White | Texas | ..... | 3.81 | 12.50 | 0 | 0 | ..... | 4.07 |
| 442 | ..... | Dun | Brown | New Zealand. | ..... | ..... | 6.87 | 0 | 0 | ..... | 2.29 |
| 480 | ..... | Boswell Winter | Black | Utah | ..... | ..... | 3.75 | 0 | 0 | ..... | 1.25 |
| ..... | ..... | Winter Turf | Brown | Texas | ..... | ..... | ..... | 0 | 0 | ..... | ..... |

[1] Average of 2 fallow plats, 1909, hence not comparable.
[2] Killed by hot-water treatment for smut.
[3] No. 2900–2 grown as No. 2900 in 1906. It was then hand selected and divided, No. 2900–1 being a hard red and No. 2900–2 a medium hard red, like the bulk of No. 2900. The yields of No. 2900 in 1906 and No. 2900–2 for 1907 to 1911, inclusive, have been averaged under No. 2900–2.
[4] Discarded after 1910 crop; average for 5 years only.
[5] Sown at the rate of 6 pecks per acre.
[6] Discontinued as winter crop after 1910; average for 5 years only.
[7] Sown at the rate of 4 pecks per acre.
[8] Yields figured on a weight of 25 pounds to the bushel.

*Winter wheat.*—The winter wheats that have done best are the hard red type, of which the Turkey (C. I. No. 1558) is a good exam-

ple. This is the leading variety in the tests at Amarillo. The Diehl Mediterranean (C. I. No. 1395–2) is a medium hard red wheat, which stands very close to the Turkey in point of yield. It has the advantage over Turkey of having longer straw, but on the other hand it has the disadvantage of shattering more if not harvested as soon as ripe. The other hard red winter wheats follow in the table in the order of their average yield. Fretes (C. I. No. 1596), a medium hard red, and Galgalos (C. I. No. 2398), a medium hard white, two of our best spring wheats, were grown also as winter varieties for a number of years, but after 1910 were discontinued as winter sorts and grown only as spring wheats. Many other varieties not given in the table have been tested and discarded. Some of the durum varieties have been tested from fall seeding, but with poor success. The winter-wheat plats have always been seeded at the rate of 3 pecks to the acre.

*Winter spelt and emmer.*—Spelt and emmer are closely related to wheat, but are grown for feed and not for making flour. They are similar in feeding value to oats and are used for much the same purposes. The straw is of little value as feed. These grains are not as hardy as winter wheat and should be sown slightly earlier than that cereal. They have been seeded at the rate of 5 pecks to the acre in these tests. The yields reported are figured on a weight of 25 pounds to the bushel. Red Winter spelt (C. I. No. 1772) has produced an average yield of 25.07 bushels (626 pounds) to the acre for the six years. This is a greater yield than was produced by any other feed grain in these tests. Black Winter emmer (C. I. No. 2337) has not yielded quite as well as the Red Winter spelt, but the grain has a lighter and softer hull, making it a slightly more desirable feed.

*Winter barley.*—The Tennessee Winter (C. I. No. 257) is the only winter barley that has given promise of being of value for this section. The average yield to the acre for the six years was 509 pounds (10.6 bushels), as compared with 640 pounds for Turkey wheat and 503 pounds for Kansas rye. Barley is not as winter hardy as wheat and should be sown earlier. It has been seeded at the rate of 5 pecks to the acre.

*Winter rye.*—Winter rye is more hardy than winter wheat, but does not equal that grain in yield. It nearly always comes through the winter in good shape and makes a vigorous growth in the spring. It also makes fine early spring pasturage. The highest average yield of grain, 9.07 bushels, has been produced by C. I. No. 114, a variety originally obtained from Kansas.

*Winter oats.*—Winter oats has not been a success. In 1908 two varieties produced fair yields, but not enough to make oats a profit-

able crop even if such yields could be obtained frequently. All the varieties under test winterkilled in 1909 and 1910, leaving no seed for planting in 1911.

## CULTURAL EXPERIMENTS WITH WINTER WHEAT.

### RATE-OF-SEEDING TESTS.

The results of the rate-of-seeding experiments are given in Table XX. These results are not exactly comparable in all the details, but the data have been arranged so as to have as few varying factors as possible. The average of all the tests is in favor of the lightest seeding, though this was not the case each year. Three pecks to the acre is the rate which is recommended under average conditions. With a good seed bed and good, clean seed 2 pecks or even 1½ pecks to the acre might be sufficient, though in favorable seasons heavier seeding would produce larger yields. The plats in this test were sown September 26, 1906, October 10, 1907, October 27, 1909, and November 16, 1910.

TABLE XX.— *Yields obtained in rate-of-seeding tests with winter wheat at Amarillo, Tex., in 1907, 1908, 1910, and 1911.*

| C. I. No. | Year and variety. | Rate of seeding. | Yield per acre (bushels). | | | Remarks. |
|---|---|---|---|---|---|---|
| | | | Light seeding. | Medium seeding. | Heavier seeding. | |
| | 1907. | *Pecks.* | | | | |
| | | 3 | 2.75 | ..... | ..... | Every drill row. |
| 2208 | Kharkof | 3½ | ..... | 1.83 | ..... | Do. |
| | | 4 | ..... | ..... | 1.50 | Do. |
| | Average | ..... | 2.75 | 1.83 | 1.50 | |
| | 1908. | | | | | |
| | | 1½ | 12.66 | ..... | ..... | Every other drill row. |
| 2339 | Beloglina | 3 | ..... | 8.16 | ..... | Every drill row. |
| | | 3 | ..... | ..... | 6.50 | Every other drill row. |
| | Average | ..... | 12.66 | 8.16 | 6.50 | |
| | 1910. | | | | | |
| | | 1½ | 6.50 | ..... | ..... | Do. |
| 2223 | Turkey | 3 | ..... | 10.92 | ..... | Every drill row. |
| | | 1½ | 5.63 | ..... | ..... | Every other drill row. |
| 1558 | .....do | 3 | ..... | 8.79 | ..... | Every drill row. |
| | | 4 | ..... | ..... | 9.42 | Do. |
| | | 1½ | 4.50 | ..... | ..... | Every other drill row. |
| 2208 | Kharkof | 3 | ..... | 6.00 | ..... | Every drill row. |
| | | 4 | ..... | ..... | 7.75 | Do. |
| | Average | ..... | 5.54 | 8.57 | 8.58 | |
| | 1911. | | | | | |
| 1558 | Turkey | 3 | ..... | 1.58 | ..... | Do. |
| | | 4 | ..... | ..... | 1.54 | |
| 2208 | Kharkof | 3 | ..... | 1.63 | ..... | Do. |
| | | 4 | ..... | ..... | 2.17 | |
| | Average | ..... | ..... | 1.60 | 1.85 | |

DATE-OF-SEEDING TESTS.

The results of the different dates of seeding for winter wheat are presented in Table XXI. The results are strictly comparable, as the only varying factor in any one year is the date of seeding. The medium seeding for 1907 and the early seeding for 1908 are lacking. In the fall of 1910 the plats in this test were sown at the usual time, but owing to lack of moisture in the soil none of the seed germinated till the following spring, making the results valueless in this test; hence, the 1911 figures are not included. The latest seedings here given show the best average results. The time recommended for seeding winter wheat is from October 15 to November 1.

TABLE XXI.— *Yields obtained in date-of-seeding tests with winter wheat at Amarillo, Tex., in 1907, 1908, and 1910.*[1]

| C. I. No. | Year and variety. | Date of seeding. | Yield per acre (bushels). Early seeding. | Medium seeding. | Late seeding. |
|---|---|---|---|---|---|
| | 1907. | 1906. | | | |
| 1558 | Turkey | Sept. 26 | 3.26 | ..... | ..... |
| | | Nov. 3 | ..... | ..... | 7.80 |
| | Average | ..... | 3.26 | ..... | 7.80 |
| | 1908. | 1907. | | | |
| 1667 | Beloglina | Oct. 10 | ..... | 13.50 | ..... |
| | | Nov. 2 | ..... | ..... | 15.41 |
| 1563 | Weissenberg | Oct. 10 | ..... | 7.36 | ..... |
| | | Nov. 2 | ..... | ..... | 11.00 |
| 1395–2 | Diehl Mediterranean | Oct. 10 | ..... | 21.66 | ..... |
| | | Nov. 2 | ..... | ..... | 30.00 |
| 2943 | Hard red winter | Oct. 10 | ..... | 9.66 | ..... |
| | | Nov. 2 | ..... | ..... | 12.66 |
| | Average | ..... | ..... | 13.04 | 17.27 |
| | 1910. | 1909. | | | |
| 1395–2 | Diehl Mediterranean | Oct. 4 | 10.42 | ..... | ..... |
| | | 22 | ..... | 9.88 | ..... |
| | | Nov. 5 | ..... | ..... | 8.96 |
| 1667 | Beloglina | Oct. 4 | 10.54 | ..... | ..... |
| | | 22 | ..... | 10.88 | ..... |
| | | Nov. 5 | ..... | ..... | 10.50 |
| 2942 | Rieti | Oct. 4 | 5.38 | ..... | ..... |
| | | 22 | ..... | Failed. | ..... |
| | | Nov. 5 | ..... | ..... | Failed. |
| 1558 | Turkey | Oct. 4 | 11.67 | ..... | ..... |
| | | 22 | ..... | 10.17 | ..... |
| | | Nov. 5 | ..... | ..... | 10.50 |
| 2208 | Kharkof | Oct. 4 | 10.71 | ..... | ..... |
| | | 22 | ..... | 8.38 | ..... |
| | | Nov. 5 | ..... | ..... | 8.58 |
| | Average | ..... | 9.74 | 7.86 | 7.71 |

[1] The 1911 test was seeded in the fall of 1910 on the usual dates, but owing to lack of moisture in the soil none of it germinated until about March 1, 1911. For this test it was an entire failure.

DATE-OF-PLOWING AND DATE-OF-SEEDING TESTS.

Table XXII presents the results of a test of different dates of plowing and seeding with Kharkof wheat (C. I. No. 2208). The seed was sown at the rate of 3 pecks to the acre. In this test early plow-

ing and late seeding gave the highest yield. The long interval between plowing and seeding seems to be the factor largely responsible for the increase obtained. This table also indicates that when the land is prepared just before seeding, deep plowing does not give as good results as shallow preparation. Good preparation, as the term is used in this bulletin, means plowing to a depth of 6 inches or more, while poor preparation means plowing or disking that stirs the soil to a depth of 3 inches or less.

In a further test, Turkey wheat (C. I. No. 1558), seeded at the rate of 3 pecks to the acre, was used (Table XXII). The longer interval between plowing and seeding gave the best results in all cases. Where the seeding was done shortly after the preparation of the land the best results were secured by disking. The disking stirs the surface soil only and leaves the subsoil compacted; no time is then required for the soil to settle. Good plowing is best done early in the summer. The latest seeding gave the best results in each case.

TABLE XXII.— *Yields obtained in date-of-plowing and date-of-seeding tests with Kharkof and Turkey winter wheats at Amarillo, Tex., in 1908.*

KHARKOF WINTER WHEAT.

| Date of plowing. | Date of seeding. | Interval between plowing and seeding. | Kind of preparation. | Yield per acre. |
|---|---|---|---|---|
| 1907. | 1907. | *Days.* | | *Bush.* |
| Aug. 12 | Nov. 2 | 82 | Good | 17.00 |
| Aug. 9 | Oct. 8 | 60 | do | 14.33 |
| Sept. 25 | do | 13 | do | 11.66 |
| Oct. 8 | do | None. | Poor | 12.66 |

TURKEY WINTER WHEAT.

| Date of seeding. | Plowed Aug. 14. | Plowed Sept. 6. | Double disked Aug. 20 and Sept. 6. | Average yield for date of seeding. |
|---|---|---|---|---|
| 1907. | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Sept. 14 | 6.0 | 6.2 | 9.1 | 7.1 |
| Oct. 10 | 5.7 | 7.0 | 9.8 | 7.5 |
| Do | 8.8 | 14.6 | 13.8 | 12.4 |
| Nov. 2 | 26.0 | 22.1 | 21.6 | 23.2 |
| Average yield for date of plowing | 11.62 | 12.47 | 13.57 | |

In 1906 some additional information relative to the preparation of land for fall-sown small grains was obtained. Plats of Fretes (C. I. No. 1596), a common spring wheat, and Kubanka (C. I. No. 2246), a durum spring wheat, were sown in the fall of 1905 on sod land that had been broken the previous summer. Plats for each variety were double

disked before seeding, while others were deeply replowed just previous to sowing the seed. The disked plat of the Fretes wheat yielded at the rate of 19.37 bushels to the acre, while two fall-plowed plats averaged 10.74 bushels. Similar results were obtained from the Kubanka durum wheat, the disked plat yielding 13.41 bushels and the fall-plowed plat 6 bushels.

From these tests it is apparent that best results may ordinarily be obtained from seeding winter wheat about October 15 to November 1, on land that has been plowed the previous summer and given good cultivation to conserve the moisture. Thorough disking is to be preferred to plowing when the land is not prepared till near seeding time.

### SOIL-PREPARATION TESTS.[1]

In Table XXIII will be found the annual and average yields obtained in a test of the different methods of soil preparation for winter wheat. The variety used in this test was Kharkof (C. I. No. 2208).

TABLE XXIII.—*Annual and average yields obtained in soil-preparation tests with winter wheat at Amarillo, Tex., for the years 1907, 1908, 1909, and 1911.*[1]

| Preparation and condition of the field. | Yield per acre (bushels). | | | | |
|---|---|---|---|---|---|
| | [2] 1907 | 1908 | 1909 | 1911 | Average. |
| Shallow fall plowing after winter wheat | 1.66 | 12.66 | 0 | 3.80 | 5.48 |
| Deep fall plowing after winter wheat | 1.41 | 14.33 | 0 | 3.80 | 6.04 |
| Clean-tilled summer fallow | 2.33 | 16.91 | 2.83 | 4.80 | 8.18 |
| Deep fall plowing and subsoiled after winter wheat | 2.08 | 16.50 | 0 | 1.20 | 5.90 |
| Listed after winter wheat and dragged level during summer | 3.41 | 15.33 | 0 | 2.20 | 5.84 |
| Disked and stubbled in after corn | 2.75 | 11.66 | 0 | 1.20 | 4.28 |
| Rye turned under and kept cultivated | [3] 2.18 | 15.00 | 0 | 2.07 | 5.69 |
| Cowpeas turned under and kept cultivated | 2.66 | 12.66 | 0 | [4] 2.16 | 4.94 |

[1] The 1910 crop is not included, as it was on new land which was all treated alike.
[2] The 1907 crop is not included in the averages, as it was severely damaged by hail. Actual yields are given; the estimated damage was 75 per cent.
[3] Sorghum instead of rye was turned under in 1906.
[4] Canada field peas instead of cowpeas were turned under in 1910.

### ENVIRONMENTAL EXPERIMENT.

The object of this experiment, which is conducted in cooperation with the Bureau of Chemistry of the United States Department of Agriculture, is primarily to determine the influence of environment on the chemical composition of winter wheat, comparing continuously home-grown seed with that grown at certain widely separated stations. Not only is the chemical composition determined, but the

[1] The soil-preparation tests are conducted cooperatively by the Office of Dry-Land Agriculture under the direction of Prof. E. C. Chilcott, Agriculturist in Charge. The results of these tests with winter wheat, spring wheat, oats, barley, corn, milo, and kafir are presented in Tables XXIII, XXVIII, XXXII, XXXVI, XL, and XLII, respectively. In all these tables the term "deep plowing" is used to describe plowing 8 inches deep, while the term "shallow plowing" refers to plowing 3 inches deep. These tables are presented as a part of the cereal experiments of the farm. No discussion of the results is included, since the data have already been presented in Bulletin 187 of the Bureau of Plant Industry.

yield, color, and hardness of the grain as well. Only the data on yield are presented in Table XXIV. In two of the three years for which data are presented, home-grown seed yielded more than that obtained from elsewhere. In only one case, that of the California seed in 1911, has the yield from other seed exceeded that from home-grown seed. A satisfactory explanation can not be given for this instance, though the fact that all seed planted in the fall of 1910 failed to germinate until about March 1 following may have been a factor.

TABLE XXIV.—*Annual and average yields obtained in an environmental experiment with winter wheat at Amarillo, Tex., from 1907 to 1911, inclusive.*

| Where seed was grown. | Yield per acre (bushels). | | | | | |
|---|---|---|---|---|---|---|
| | 1907 | 1908 | [1] 1909 | 1910 | 1911 | Average. |
| Amarillo, Tex. (home grown) | 3.00 | 0 | No seed. | 10.38 | 2.29 | 3.92 |
| Marysville, Cal. | 2.68 | 0 | 0.16 | 6.29 | 6.75 | 3.93 |
| Hays, Kans. | 2.08 | 0 | .66 | 6.58 | 2.04 | 2.67 |

[1] Not included in the averages.

This experiment was started with seed of the Crimean (C. I. No. 1437), a hard red winter wheat, grown at Hays, Kans., in 1905. It was grown at the three points mentioned in the table in 1906 and seed sent from each to the other two. This method of sending seed from the home-grown plat at each place to the other two places is followed each year. The following exceptions must be noted: The seed planted at Amarillo, Tex., in the fall of 1907 was given the hot-water treatment for smut and failed to germinate. This left Amarillo without home-grown seed. Seed was received from the other two points in the fall of 1908 and planted at Amarillo, but no seed was sent from Amarillo to the other points. The yield at Amarillo in 1909 was so small that there was no seed to send to the other two points. All the home-grown seed at Amarillo was planted on one plat. This closes the gap at Amarillo, but not until 1911 did the other two points have crops again from Amarillo seed. Seeding dates were September 26, 1906; October 10, 1907; November 2, 1908; October 23, 1909; and November 12, 1910. The rate of seeding was 3 pecks per acre. The station in California has been changed from Marysville to Davis, but as both are in the Sacramento Valley and not far apart the change did not affect this experiment.

### EXPERIMENTS WITH SPRING SMALL GRAINS.

The experiments with spring small grains have included tests of wheat, oats, barley, proso, flax, and buckwheat. A large number of varietal tests have been conducted, while cultural experiments

with the more important cereals have been given considerable attention. In the following pages these are reported separately for each cereal.

## Experiments with Spring Wheat.

### VARIETAL TESTS.

The yields obtained from varietal tests of common and durum spring wheat are presented in Table XXV, the durum varieties being listed first.

Table XXV.—*Annual and average yields obtained in varietal tests with spring wheats at Amarillo, Tex., for the years 1906 to 1911, inclusive.*

| C. I. No. | S. P. I. No. | Name. | Origin. | Yield of grain per acre (bushels). | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
| | | DURUM WHEATS. | | | | | | | | |
| 2235 | 9324 | Marouani [1] | Algeria | 5.33 | 10.40 | 16.83 | 5.66 | 2.75 | 11.63 | 8.77 |
| 2228 | 9130 | Saragolla [1] | Italy | 7.61 | 8.45 | 15.33 | 6.50 | 2.71 | 11.13 | 8.62 |
| 2246 | 10364 | Kubanka [1] | Russia | 8.04 | 4.30 | 16.83 | 5.85 | 3.08 | 9.33 | 7.90 |
| 1593 | 7578 | Marouani [2] | Algeria | 6.42 | 6.25 | 15.86 | ..... | 5.67 | 9.57 | 8.75 |
| 2941 | ..... | ..... | ..... | 5.91 | 7.75 | 19.00 | ..... | ..... | ..... | 10.88 |
| 2882 | 15788 | Kubanka | Russia | 6.83 | 6.20 | 15.66 | ..... | ..... | ..... | 9.56 |
| 1597 | 7579 | Medeah | Algeria | 6.87 | 5.56 | 14.00 | ..... | ..... | ..... | 8.81 |
| 2100 | 13855 | Black Don | Russia | 5.16 | 5.01 | 15.00 | ..... | ..... | ..... | 8.39 |
| 2934 | ..... | ..... | ..... | 5.54 | 8.01 | ..... | ..... | ..... | ..... | ..... |
| 2247 | 9479 | Velvet Don | Russia | ..... | 7.56 | 15.16 | ..... | ..... | ..... | ..... |
| 2087 | 7793 | Mohammed ben Bachir | Algeria | ..... | 11.50 | 18.00 | .. .. | ..... | ..... | ..... |
| 2099–III [3] | ..... | ..... | ..... | ..... | ..... | 16.50 | ..... | 4.58 | 10.30 | 10.46 |
| 2091–III | ..... | ..... | ..... | ..... | ..... | 14.66 | ..... | 3.50 | 10.50 | 9.55 |
| 2091–IX | ..... | ..... | ..... | ..... | ..... | 14.66 | ..... | 3.71 | 6.54 | 8.30 |
| 2094–III | ..... | ..... | ..... | ..... | ..... | .. .. | 13.66 | [4] 3.19 | 11.23 | 9.36 |
| 2099–I | ..... | ..... | ..... | ..... | ..... | ..... | 7.83 | 4.29 | 14.83 | 8.98 |
| 2096–I | ..... | ..... | ..... | ..... | ..... | ..... | 5.83 | 3.13 | 12.58 | 7.18 |
| 2221 | ..... | ..... | ..... | ..... | ..... | ..... | 7.50 | 2.29 | 11.21 | 7.00 |
| 2086–II | ..... | ..... | ..... | ..... | ..... | ..... | 3.33 | 4.33 | 12.88 | 6.84 |
| 2537–I–II | ..... | ..... | ..... | ..... | ..... | ..... | 2.66 | 3.00 | 13.29 | 6.31 |
| 2089–VI | ..... | ..... | ..... | ..... | ..... | ..... | 3.00 | 3.50 | 11.83 | 6.11 |
| 2088–VIII | ..... | ..... | ..... | ..... | ..... | ..... | 3.00 | 4.08 | 9.67 | 5.58 |
| 2089–V | ..... | ..... | ..... | ..... | ..... | ..... | 2.00 | 4.29 | 10.08 | 5.45 |
| 2088–III | ..... | ..... | ..... | ..... | ..... | ..... | 2.33 | 3.33 | 10.21 | 5.29 |
| 2087–II | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 5.88 | 9.67 | 7.77 |
| 2087–III | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 4.92 | 8.83 | 6.87 |
| 2222–V | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.13 | 10.46 | 6.79 |
| 2222–VI | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.04 | 10.17 | 6.60 |
| 2091–XI | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.67 | 7.63 | 5.65 |
| 2077 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9.04 | ..... |
| 1576 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 7.54 | ..... |
| | | COMMON WHEATS. | | | | | | | | |
| 1596 | 7582 | Fretes | Algeria | 5.08 | 10.68 | 19.50 | 8.50 | 3.56 | 9.04 | 9.39 |
| 2398 | 9872 | Galgalos | Russia | 4.90 | 10.56 | 18.00 | 7.50 | 3.92 | 10.98 | 9.31 |
| 2227 | 15802 | Chul | Turkestan | 6.08 | 5.53 | [5] | 3.50 | 3.52 | 8.71 | 5.46 |
| 2397 | 9871 | Erivan | Russia | 3.55 | 8.43 | [5] | ..... | ..... | ..... | ..... |
| 2085 | 7585 | Black Poulard | Algeria | 4.02 | ..... | ..... | ..... | ..... | ..... | ..... |
| 2946 | ..... | Barley wheat | Transvaal | 2.83 | ..... | ..... | ..... | ..... | ..... | ..... |

[1] Grown from selected seed 1909 to 1911, inclusive.
[2] Grown from selected seed 1910 and 1911.
[3] Roman numerals following a Cereal Investigation number indicate selections from the original grain of that number.
[4] Average of six check plats.
[5] Thrown out in 1908 on account of being very badly smutted.

It will be seen from the table that a much larger number of varieties of durum than of common spring wheat have been tested. Only three durum and two common wheats have been grown during the full period of six years. The two common wheats (Fretes, C. I. No. 1596; and Galgalos, C. I. No. 2398) made better average yields than any of the durums (Marouani, C. I. No. 2235; Saragolla, C. I. No. 2228; and Kubanka, C. I. No. 2246), but were slightly lower in yield than the two best winter wheats (Turkey, C. I. No. 1558, and Diehl Mediterranean, C. I. No. 1395–2).[1] This leads to the conclusion that for the Panhandle region the groups of wheat rank in the following order: (1) Winter wheat, (2) common spring wheat, and (3) durum wheat. The Fretes is a medium hard red wheat, while the Galgalos would be classed as a medium hard white variety.

### RATE-OF-SEEDING TESTS.

Experiments have been conducted each year in an effort to determine the proper rates of seeding for spring wheat. The results will be found in Table XXVI for the years 1906, 1908, 1909, 1910, and 1911. One criticism that might be made of this series of tests is that it has not been uniform in that the same varieties and the same rates of seeding have not been used each year. On the whole, however, the indications are that 4 pecks to the acre for the common wheats and 5 pecks for the durum wheats are the rates at which they should be seeded ordinarily. The weather conditions, the condition of the seed bed, and the viability of the seed all have such important effects on the crop that they must all be taken into consideration in determining the rate at which it is best to seed a given field.

TABLE XXVI.— *Yields obtained in rate-of-seeding tests with spring wheat at Amarillo, Tex.*

1906.

| C. I. No. | S. P. I. No. | Variety. | Kind of wheat. | Rate of seeding. | Yield per acre. | C. I. No. | S. P. I. No. | Variety. | Kind of wheat. | Rate of seeding. | Yield per acre. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *Pecks.* | *Bush.* | | | | | *Pecks.* | *Bush.* |
| 2228 | 9130 | Saragolla | Durum | 5 | 7.61 | 2227 | 15802 | Chul | Common | 4 | 6.09 |
| | | | | 6 | 6.70 | | | | | 6 | 4.72 |
| 1597 | 7579 | Medeah | do | 4 | 6.62 | 2398 | 9872 | Galgalos | do | 4 | 4.90 |
| | | | | 7 | 6.87 | | | | | $6\frac{3}{4}$ | 3.42 |
| 1593 | 7578 | Marouani | do | 7 | [2] 5.46 | 2946 | ..... | Sonora | do | $3\frac{1}{2}$ | 1.95 |
| | | | | 8 | 4.12 | | | | | 4 | 2.83 |
| 2941 | ..... | ..... | do | 4 | 5.41 | 2035 | 7585 | Black Poulard | Poulard | 4 | 4.02 |
| | | | | 6 | 5.91 | | | | | 7 | 3.14 |
| 2235 | 9324 | Marouani | do | 6 | 3.83 | | | | | | |
| | | | | 8 | 5.33 | | | | | | |



[1] See p. 42.

[2] Average of two plats.

TABLE XXVI.— *Yields obtained in rate-of-seeding tests with spring wheat at Amarillo, Tex.*—Continued.

1908.

| C. I. No. | S. P. I. No. | Variety. | Kind of wheat. | Yield per acre (bushels). Seeded at 4-peck rate. | Seeded at 5-peck rate. | Seeded at 6-peck rate. |
|---|---|---|---|---|---|---|
| 1593 | 7578 | Marouani | Durum | ..... | 15.86 | 14.26 |
| 2087 | 7793 | Mohammed ben Bachir | do | ..... | 18.00 | 16.66 |
| 1596 | 7582 | Fretes | Common | 17.33 | 16.53 | ..... |
| 2398 | 9872 | Galgalos | do | 15.73 | 14.26 | ..... |
| Average of 2 varieties durum wheat | | | | ..... | 16.93 | 15.46 |
| Average of 2 varieties common wheat | | | | 16.53 | 15.39 | ..... |

1909.

| C. I. No. | Variety. | Rate of seeding. | Space between rows.[1] | Yield per acre. |
|---|---|---|---|---|
| | | *Pecks.* | *Inches.* | *Bushels.* |
| 2398 | Galgalos | 1½ | 12 | 0 |
| | | 3 | 6 | 4.33 |
| | | 4 | 6 | 5.16 |
| | | 5 | 6 | 4.83 |

1910.

| C. I. No. | S. P. I. No. | Variety. | Kind of wheat. | Yield per acre (bushels). Seeded at 3-peck rate. | Seeded at 4-peck rate. | Seeded at 5-peck rate. |
|---|---|---|---|---|---|---|
| 2246 | 10364 | Kubanka | Durum | 2.92 | 2.83 | 2.96 |
| 2398 | 9872 | Galgalos | Common | 4.42 | 3.58 | 3.50 |

1911.

| | | | | | | |
|---|---|---|---|---|---|---|
| 2235–I | ..... | Marouani | Durum | 14.42 | 14.50 | 10.58 |
| 2398 | 9872 | Galgalos | Common | 12.00 | 13.08 | ..... |

[1] Where the rows were 12 inches apart weeds started between the rows and choked the wheat. Where the rows were 6 inches apart the wheat kept ahead of the weeds, which did not grow large.

## DATE-OF-SEEDING TESTS.

The proper date on which spring wheats should be sown in the Panhandle region depends so much upon the amount of moisture in the soil that no very definite conclusion can be drawn. The time of seeding ranges from the last of February to about the middle of April. If there is plenty of moisture in the soil early seeding is recommended. If the soil moisture is deficient, later seeding will probably give better results. In 1908 (Table XXVII) larger yields were obtained from the later seeding, while in 1910 the opposite was true. The difference in 1910, however, was very slight.

TABLE XXVII.—*Yields obtained in date-of-seeding tests with spring wheat at Amarillo, Tex., in 1908 and 1910.*

| 1908. | | | | | | 1910. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C. I. No. | S. P. I. No. | Variety. | Kind of wheat. | Yield per acre (bushels). | | C. I. No. | Variety. | Kind of wheat. | Yield per acre (bushels). | |
| | | | | Sown Feb. 28. | Sown Mar. 16. | | | | Sown Mar. 14. | Sown Apr. 1. |
| 2235 | 9324 | Marouani | Durum | 16.33 | 16.83 | 1596 | Fretes | Common | [1] 3.56 | 3.79 |
| 2398 | 9872 | Galgalos | Common | 15.83 | 18.00 | 2398 | Galgalos | do | [1] 3.92 | 2.08 |
| | | | | | | 2228–I | Saragolla | Durum | 2.71 | 3.50 |
| | | | | | | 2235–I | Marouani | do | 2.75 | 3.63 |
| | | | | | | 2094–III | Kubanka | do | [1] 3.12 | 2.67 |
| Average | | | | 16.08 | 17.41 | | | | 3.21 | 3.13 |

[1] Average of two plats.

SOIL-PREPARATION TESTS WITH DURUM WHEAT.

In Table XXVIII, the data obtained at Amarillo in the soil-preparation tests for spring wheat conducted by the Office of Dry-Land Agriculture are presented.[1] In 1907, Kubanka (C. I. No. 2246) was used, while in 1908 and succeeding years Saragolla (C. I. No. 2228) was grown.

TABLE XXVIII.—*Annual and average yields obtained in soil-preparation tests with durum wheat at Amarillo, Tex., for the years 1907, 1908, 1909, and 1911.*[1]

| Preparation and condition of the field. | Yield per acre (bushels). | | | | |
|---|---|---|---|---|---|
| | [2] 1907 | 1908 | 1909 | 1911 | Average. |
| Shallow spring plowing after spring wheat | 2.50 | 17.00 | 0 | 7.30 | 8.10 |
| Deep spring plowing after spring wheat | 1.83 | 15.33 | 0 | 11.40 | 8.91 |
| Deep fall plowing after spring wheat | 1.66 | 14.00 | 2.83 | 10.00 | 8.94 |
| Clean-tilled summer fallow | 2.83 | 16.50 | 10.00 | 18.52 | 15.01 |
| Deep fall plowing and subsoiled after spring wheat | 2.16 | 16.16 | 4.00 | 11.30 | 10.48 |
| Listed after spring wheat and dragged level during summer | 1.91 | 14.33 | 0 | 12.90 | 9.07 |
| Disked and stubbled in after corn | 1.00 | 8.33 | 0 | 12.10 | 6.81 |
| Deep spring plowing after corn | 2.83 | 8.00 | 0 | 11.60 | 6.53 |
| Deep fall plowing after corn | 1.41 | 8.50 | 0 | 5.70 | 4.73 |
| Deep fall plowing after oats | 1.00 | 13.36 | 0 | 6.20 | 6.52 |
| Deep spring plowing after oats | 1.33 | 5.33 | 0 | 6.80 | 4.04 |
| Cowpeas turned under and kept cultivated | 2.50 | 19.66 | 0 | [3] 11.40 | 10.35 |
| Rye turned under and kept cultivated | [4] 1.58 | 14.16 | 4.33 | 7.50 | 8.66 |

[1] The 1910 crop is not included, as it was on new land which was all treated alike.
[2] The 1907 crop is not included in the averages, as it was severely damaged by hail. The actual yields are given; the estimated damage was 75 per cent.
[3] Canada field peas instead of cowpeas were plowed under in 1910.
[4] Sorghum instead of rye was plowed under in 1906.

EXPERIMENTS WITH SPRING OATS.

VARIETAL TESTS.

Though not considered one of the leading crops of the Panhandle, spring oats have given uniformly better results than the other spring small grains. All yields are figured at 32 pounds per bushel, though

[1] See footnote on page 47.

the average test here is between 27 and 28 pounds. The results of the varietal tests are given in Table XXIX. The varieties are arranged in the table according to the number of years they have been grown and in the order of their average yields for those periods.

TABLE XXIX.—*Annual and average yields obtained in varietal tests with spring oats at Amarillo, Tex., for the years 1906 to 1911, inclusive*

| C. I. No. | S. P. I. No. | Name. | Color of grain. | Origin. | Yield per acre (bushels). | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
| 286 | 12133 | Red Algerian | Red | Algeria | 15.96 | 17.59 | 38.12 | 17.81 | 11.41 | 17.86 | 19.62 |
| 458 | ..... | Red Rustproof | do | ..... | 19.76 | [1] 19.30 | [1] 32.65 | [1] 9.68 | [1] 8.98 | 17.81 | 18.03 |
| 286 | 15858 | Red Algerian | do | Algeria | 10.62 | 20.37 | 30.31 | 19.06 | 10.94 | 16.25 | 17.92 |
| 165 | 5938 | Sixty-Day | Yellow | Russia | 21.14 | 20.93 | 30.63 | 19.68 | 5.83 | 8.83 | 17.84 |
| 337 | 5168 | Seventy-five Day | do | do | 12.39 | 22.65 | 24.06 | 18.12 | 4.45 | 17.03 | 16.45 |
| 293 | 15856 | Burt | Brown | ..... | 13.33 | 16.15 | 23.43 | 16.56 | 7.97 | 18.67 | 16.01 |
| 459 | ..... | Kherson | Yellow | Russia | 11.51 | 15.15 | 20.62 | 19.06 | 4.53 | 16.72 | 14.59 |
| 293 | 16865 | Burt | Brown | ..... | 12.88 | 14.53 | 22.12 | 0 | 6.64 | 20.94 | 12.85 |
| 165 | 17720 | Sixty-Day | Yellow | Russia | ..... | 24.37 | 32.50 | 16.25 | 3.91 | 11.72 | 17.75 |
| 487 | 20370 | Red Siberian | do | Siberia | ..... | 14.65 | 31.87 | 17.81 | 10.08 | 6.64 | 16.21 |
| 293–VI | ..... | Selection from Burt | Brown | ..... | ..... | 10.34 | 23.43 | 12.81 | 9.30 | 20.63 | 15.30 |
| 537 | 17451 | Burt | do | ..... | ..... | 6.87 | 24.75 | 8.75 | 6.95 | 20.55 | 13.57 |
| 535 | 17148 | Kherson | Yellow | Russia | ..... | 14.06 | 16.25 | 2.81 | ..... | ..... | ..... |
| 165 | 15857 | Sixty-Day | do | do | 10.80 | 14.37 | ..... | ..... | ..... | ..... | ..... |
| 293 | 11145 | Burt | Brown | ..... | 17.43 | 15.50 | ..... | ..... | ..... | ..... | ..... |
| 336 | 10624 | Belyak | Red | Russia | 8.07 | 14.00 | ..... | ..... | ..... | ..... | ..... |
| 254 | 8650 | North Finnish Black | Black | Finland | 15.00 | ..... | ..... | ..... | ..... | ..... | ..... |
| 213 | 10330 | Swedish Select | Yellow | Russia | 9.30 | ..... | ..... | ..... | ..... | ..... | ..... |
| 165–I | ..... | Selection from Sixty-Day. | do | ..... | ..... | 11.03 | ..... | 0 | 7.73 | 12.43 | 7.79 |

[1] Average of two plats.

Of the eight varieties which have been grown for the six years from 1906 to 1911, inclusive, the highest average yields have been obtained from Red Algerian (C. I. No. 286) and Red Rustproof (C. I. No. 458). Two plats of the latter variety were grown in 1907, 1908, 1909, and 1910. The failure of Burt (C. I. No. 293) in 1909 and the low yields of Red Rustproof (C. I. No. 458), Burt (C. I. No. 537), and Kherson (C. I. No. 535) the same year were due to the fact that they were planted on ground which had grown grain sorghum in 1908, while the other varieties followed durum spring wheat. If it had been grown under strictly comparable conditions that year, it is possible that the Red Rustproof (C. I. No. 458) might have equaled or exceeded the Red Algerian in yield. These two varieties are of much the same type. The Sixty-Day and the Seventy-five Day, two varieties from southern Russia, with small yellow kernels, have yielded slightly less than Red Algerian and Red Rustproof. None of the varieties grown for less than six years has yielded as well as those already mentioned, from averages including the same years.

### RATE-OF-SEEDING TESTS.

The rate-of-seeding tests for spring oats have been carried on rather irregularly. As in similar tests with spring wheats, these experiments have not been conducted uniformly. The rates have been comparable for the individual years but not for the consecutive crops.

The results for 1906 (Table XXX) are in favor of the medium seeding for that year. This medium seeding was 2¼ times as much as the lighter seeding of 1908, which gave the best yields of any test that year. In 1911, the heavier rate produced the best average yield.

TABLE XXX.—*Yields obtained in rate-of-seeding tests with spring oats at Amarillo, Tex., in 1906, 1908, and 1911.*

| C. I. No. | S. P. I. No. | Year and variety. | Rate of seeding. | Yield per acre. | C. I. No. | S. P. I. No. | Year and variety. | Rate of seeding. | Yield per acre. |
|---|---|---|---|---|---|---|---|---|---|
| | | 1906. | *Pecks.* | *Bush.* | | | 1906. | *Pecks.* | *Bush.* |
| 165 | 5938 | Sixty-Day | 9 | 21.14 | 254 | 8650 | North Finnish Black | 6 | 15.00 |
| | | | 13 | 19.64 | | | | 9 | 11.78 |
| 458 | ..... | Red Rustproof | 9 | 19.76 | 293 | 16865 | Burt | 6 | 12.88 |
| | | | 13 | [1] 9.45 | | | | 9 | 11.40 |
| 293 | 11145 | Burt | 9 | 16.02 | 165 | 15857 | Sixty-Day | 6 | 10.23 |
| | | | 13 | 17.43 | | | | 9 | 10.80 |
| 286 | 12133 | Red Algerian | 6 | 15.96 | 213 | 10330 | Swedish Select | 6 | 9.30 |
| | | | 13 | 11.82 | | | | 13 | 7.85 |

| C.I.No. | S.P.I. No. | Year and variety. | Yield per acre (bushels). | | C.I.No. | S.P.I. No. | Year and variety. | Yield per acre (bushels). | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Seeded at 4-peck rate. | Seeded at 6-peck rate. | | | | Seeded at 5-peck rate. | Seeded at 6-peck rate. |
| | | 1908. | | | | | 1911. | | |
| 165 | 5938 | Sixty-Day | 25.00 | 25.63 | 487 | 20370 | Red Siberian | 6.64 | 14.61 |
| 286 | 12133 | Red Algerian | 38.12 | 32.38 | 286 | 12133 | Red Algerian | 13.28 | 14.42 |
| 286 | 15858 | do | 30.31 | 29.37 | 286 | 15858 | do | 16.25 | 15.00 |
| 293 | 15856 | Burt | 21.12 | 21.56 | 165–1 | ..... | Sixty-Day | 13.98 | 15.00 |
| 458 | ..... | Red Rustproof | 32.50 | 24.75 | | | | | |
| 458 | 19233 | do | 32.81 | 32.50 | | | | | |
| | | Average | 29.97 | 27.70 | ..... | ..... | ..... | 12.54 | 14.76 |

[1] An old road ran through this plat.

In 1906 the average yield of three varieties was 12.70 bushels to the acre from the 6-peck rate and 11.33 bushels from the 9-peck rate; the average of two varieties seeded at 6 and 13 pecks was 12.63 and 9.83 bushels for the respective rates of seeding; and the average of two varieties seeded at 9 and 13 pecks was 18.58 for the 9-peck and 18.53 bushels for the 13-peck rate. The Red Rustproof (C. I. No. 458) is not included in the latter averages, because the yield of this variety at the 13-peck rate is not comparable. In 1908 all the varieties were seeded at the uniform rates of 4 and 6 pecks to the acre. The six plats seeded at the rate of 4 pecks to the acre averaged 29.97 bushels, while those seeded at the rate of 6 pecks averaged 27.70 bushels, a difference of 2.77 bushels in favor of the 4-peck rate when the 2-peck difference in rate of seeding is taken into account. The four 5-peck plats averaged 12.54 bushels to the acre in 1911, while the four 6-peck plats averaged 14.76 bushels, a net

difference of 1.97 bushels to the acre in favor of the heavier rate of seeding. This difference, however, is due almost entirely to the low yield of the Red Siberian variety from the 5-peck seeding, for which there is no adequate explanation.

Although the results here shown are quite contradictory, it is the opinion of the writers that 5 pecks of good, clean seed to the acre is about the rate of seeding to recommend for spring oats. This opinion has been formed by noting the results in the varietal tests as well as in the regular rate-of-seeding tests.

### DATE-OF-SEEDING TESTS.

Not very much work has been done with date-of-seeding tests of spring oats, this crop having generally been seeded as early in the spring as possible. When they have been sown early good results have nearly always been obtained. This was especially true in 1908, when nearly all the oat plats were seeded the latter part of February and early in March. In 1910 the early seeding gave very much better results than the later seeding (Table XXXI).

TABLE XXXI.— *Yields obtained in a date-of-seeding test with spring oats at Amarillo, Tex., in 1910.*

| C. I. No. | S.P.I.No. | Variety. | Yield per acre (bushels). | |
|---|---|---|---|---|
| | | | Sown Mar. 9. | Sown Apr. 1. |
| 165 | 17720 | Sixty-Day | 3.91 | 4.16 |
| 293 | 16865 | Burt | 7.97 | 4.77 |
| 286 | 12133 | Red Algerian | 11.41 | 5.47 |
| 458 | 19233 | Red Rustproof | 8.98 | 5.63 |
| 487 | 20370 | Red Siberian | 10.08 | 4.53 |
| Average | | | 8.47 | 4.91 |

It is probable that early to medium seeding will most often produce good yields, though there are conditions under which it would be advisable to seed rather late. In the annual report of the farm superintendent for 1909, the following instance is given which illustrates conditions that may arise:

In the spring of 1909 most of the seeding of small grains was done during the first two weeks in March. The spring was unusually dry, with high winds. On the morning of May 1 the thermometer registered 19° F. All the early spring plantings were very severely injured. This frost was followed by more high winds, which added materially to the damage already done. The particles of soil carried by the wind cut the growing crop to the ground in several portions of the farm. Later in the season the Office of Alkali and Drought Resistant Plant Breeding Investigations sent seeds of various kinds to Amarillo to be planted. Among these seeds were several varieties of wheat and oats. They were all planted on May 17 on fall-plowed wheat land. This planting escaped the frost and sustained very little, if any, injury from the

severe weather conditions which prevailed later. The late plantings made a better growth of straw than the early plantings, seemed to fill better, and ripened a little later. No yield tests were made from these late plantings, as they were grown in short rows.

SOIL-PREPARATION TESTS.

The results presented in Table XXXII are those obtained in the soil-preparation tests with spring oats conducted by the Office of Dry-Land Agriculture at Amarillo.[1] The variety used in these tests was Burt (C. I. No. 293).

TABLE XXXII.—*Annual and average yields obtained in soil-preparation tests with spring oats at Amarillo, Tex., for the years 1907, 1908, 1909, and 1911.*[1]

| Preparation and condition of the field. | Yield per acre (bushels). | | | | |
|---|---|---|---|---|---|
| | [2] 1907 | 1908 | 1909 | 1911 | Average. |
| Shallow spring plowing after oats | 3.12 | 20.00 | 0 | 28.20 | 16.06 |
| Deep fall plowing after oats | 4.68 | 32.18 | 0 | 27.50 | 19.89 |
| Clean-tilled summer fallow | 6.79 | 32.49 | 24.37 | 36.15 | 31.00 |
| Deep fall plowing and subsoiled after oats | 4.53 | 28.12 | 0 | 19.20 | 15.77 |
| Listed after oats and dragged level during summer | 7.34 | 29.68 | 0 | 26.80 | 18.82 |
| Disked and stubbled in after milo | 1.65 | 19.21 | 0 | 25.80 | 15.00 |
| Disked and stubbled in after kafir | 1.87 | 16.40 | 0 | 26.65 | 14.35 |
| Disked and stubbled in after corn | 3.75 | 22.68 | 0 | 28.00 | 16.89 |
| Deep fall plowing after spring wheat | 3.69 | 26.66 | 14.33 | 26.40 | 22.46 |
| Deep spring plowing after spring wheat | 1.09 | 23.43 | 0 | 35.70 | 19.71 |
| Deep spring plowing after corn | 4.14 | 21.87 | 0 | 35.95 | 19.27 |
| Deep fall plowing after barley | 3.12 | 31.25 | 0 | 35.60 | 22.28 |
| Rye turned under and kept cultivated | [3] 4.84 | 31.87 | 5.00 | 18.00 | 18.29 |
| Cowpeas turned under and kept cultivated | 5.78 | 27.50 | 8.43 | [4] 25.90 | 20.61 |

[1] The 1910 crop is not included, as it was on new land which was all treated alike.
[2] The 1907 crop is not included in the averages, as it was severely damaged by hail. The actual yields are given; the hail damage was estimated at 75 per cent.
[3] Sorghum instead of rye was turned under in 1906.
[4] Canada field peas instead of cowpeas were plowed under in 1910.

In 1906 a yield of 36.59 bushels to the acre was obtained from a plat of Burt spring oats (C. I. No. 293) on fall plowing, while 25 plats of this variety on spring plowing in tests conducted by the Office of Dry-Land Agriculture averaged only 13.33 bushels. This evidence is very strongly in favor of fall plowing for spring oats, but it is unlikely that such a large difference in yield would ordinarily be obtained.

ENVIRONMENTAL EXPERIMENTS.

In order to test the difference in yield between home-grown seed and seed grown in some other part of the country, the experiment reported in Table XXXIII was conducted in 1906. This was before the regular environmental or trilocal experiment with the Red Rustproof oat, reported in Table XXXIV, was inaugurated. In both these experiments, better yields were obtained from home-grown seed than from that grown elsewhere. These tests indicate that it is advisable to use acclimated or home-grown seed whenever it is possible to obtain it.

[1] See footnote on p. 47.

TABLE XXXIII.—*Yields obtained in a source-of-seed test with spring oats at Amarillo, Tex., in 1906.*

| C. I. No. | S. P. I. No. | Variety. | Source of seed. | Rate of seeding. | Yield per acre. |
|---|---|---|---|---|---|
| | | | | *Pecks.* | *Bushels.* |
| 165 | [1] 5938 | Sixty-Day .... | Channing, Tex. | 9 | 21.14 |
| 165 | 15857 | .....do..... | McPherson, Kans. | 9 | 10.80 |
| 293 | [2] 11145 | Burt..... | Channing, Tex. | 9 | 16.02 |
| 293 | 16865 | .....do..... | College Park, Md. | 9 | 11.40 |
| 293 | 15856 | .....do..... | McPherson, Kans. | 10 | [3] 13.33 |

[1] The Sixty-Day oat (S. P. I. No. 5938) is the original seed from which S. P. I. No. 15857 was grown. The former had been grown at Channing, Tex., while the latter was grown at McPherson, Kans., during 1904 and 1905.

[2] The Burt oat (S. P. I. No. 11145) is the original seed from which the other two strains were grown. The Maryland and the Kansas seed were raised in those States, respectively, during 1904 and 1905, while the other was grown at Channing, Tex.

[3] Average yield from 25 plats grown by the Office of Dry-Land Agriculture.

A trilocal environmental experiment with Red Rustproof oats, similar to the one already described with Crimean wheat,[1] was begun in 1908. Seed of this variety, grown by the Tennessee Agricultural Experiment Station at Knoxville, Tenn., was obtained and sent to Amarillo, Tex., and to the experiment station at Fayetteville, Ark., while a plat was also grown at Knoxville. Each year since, seed has been sent from the plat grown from the home-grown seed at each place to the other two points. The yields obtained in this experiment are presented in Table XXXIV. The rate of seeding in this experiment is 5 pecks to the acre. The plats have been sown on March 20, 1909, March 10, 1910, and March 23, 1911.

TABLE XXXIV.—*Annual and average yields obtained in the trilocal experiment with Red Rustproof spring oats at Amarillo, Tex., in 1909, 1910, and 1911.*

| Source of seed. | Yield per acre (bushels). | | | |
|---|---|---|---|---|
| | 1909 | 1910 | 1911 | Average. |
| Amarillo, Tex. (home-grown seed) | 4.37 | 9.84 | 21.80 | 12.00 |
| Knoxville, Tenn. | 2.81 | 8.13 | 18.44 | 9.79 |
| Fayetteville, Ark. | 2.06 | 6.88 | 18.05 | 8.99 |

## EXPERIMENTS WITH SPRING BARLEY.

### VARIETAL TESTS.

Very little success has been attained in the tests of spring barley. Only one or two varieties have given results which are worthy of consideration. The Boehme Hooded (C. I. No. 507, beardless) has been grown more extensively than any of the others. It was used in the rotation and continuous-cropping plats of the Office of Dry-

[1] See p. 47.

Land Agriculture for several years, but failed to produce seed enough in 1910 for reseeding in 1911. A similar variety, the White Hooded (C. I. No. 716) was obtained and planted instead of the Boehme Hooded in 1911. The yields produced by these varieties are shown in Table XXXVI.

RATE-OF-SEEDING TEST.

The results of a rate-of-seeding test which was conducted with several varieties of spring barley in 1906 are presented in Table XXXV. These results are so variable that no definite conclusions can be drawn from them.

TABLE XXXV.— *Yields obtained in a rate-of-seeding test with spring barley at Amarillo, Tex., in 1906.*

| C. I. No. | S. P. I. No. | Variety. | Rate of seeding. | Yield per acre. | C. I. No. | S. P. I. No. | Variety. | Rate of seeding. | Yield per acre. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *Pck.* | *Bush.* | | | | *Pck.* | *Bush.* |
| | | | 4 | 4.79 | 236 | 9131 | Hanna | 4 | 3.43 |
| | | | 6½ | 6.08 | | | | 6 | 3.48 |
| 507 | 17525 | Boehme Hooded | 7 | 6.30 | 354 | 11192 | Manchuria | 4 | 1.82 |
| | | | 9 | 7.14 | | | | 6 | 3.28 |
| | | | 11 | 7.02 | 195 | 7969 | Smyrna | 4 | 1.77 |
| | | | | | | | | 6 | 0.88 |

SOIL-PREPARATION TESTS.

Table XXXVI shows the yields obtained with spring barley in 1907, 1908, 1909, and 1911 in experiments with different methods of soil preparation conducted by the Office of Dry-Land Agriculture.[1] The Boehme Hooded (C. I. No. 507) was used in 1907, 1908, and 1909 and the White Hooded (C. I. No. 716) in 1911.

TABLE XXXVI.—*Annual and average yields obtained in soil-preparation tests with spring barley at Amarillo, Tex., for the years 1907, 1908, 1909, and 1911.*[2]

| Preparation and condition of the field. | Yield per acre (bushels). | | | | |
|---|---|---|---|---|---|
| | [3] 1907 | 1908 | 1909 | 1911 | Average. |
| Shallow spring plowing after barley | 3.10 | 7.91 | 0 | 12.20 | 6.70 |
| Deep fall plowing after barley | 2.91 | 13.16 | 5.83 | 11.70 | 10.23 |
| Clean-tilled summer fallow | 5.00 | 15.20 | 17.50 | 15.00 | 15.90 |
| Deep fall plowing and subsoiled after barley | 2.70 | 11.87 | 0 | 10.30 | 7.39 |
| Listed after barley and dragged level during summer | 3.02 | 10.83 | 0 | 11.40 | 7.41 |
| Disked and stubbled in after corn | 2.50 | 7.50 | 0 | 11.80 | 6.43 |
| Deep spring plowing after oats | 2.29 | 8.13 | 0 | 12.30 | 6.81 |

[1] See footnote on p. 47.
[2] The 1910 crop is not included, as it was on new land which was all treated alike.
[3] The 1907 crop is not included in the averages, as it was severely damaged by hail. The actual yields are given.

## Experiments with Miscellaneous Cereals.

### PROSO.

Proso (*Panicum miliaceum*) is a species of millet introduced into this country from Russia. It is commonly called "hog millet" and "broom-corn millet" in the United States. It is grown for grain and not for hay. The grain is of value for feeding to live stock, particularly to hogs, sheep, and poultry. The characteristic of this grain that appeals most forcefully to the dry-land farmer is its ability to produce a crop of seed in two months or less from the time of seeding. There are several varieties of proso, the differences being mainly in the color of the seed and in the length of the straw. The seed may be white, yellow, red, or black. Some varieties have short and some have long straw, while the leaves are few in all. A black-seeded sort, the Black Voronezh (C. I. No. 27), has produced the best average yield in these tests, as shown in Table XXXVII. For the three years in which it has been grown the Yellow (C. I. No. 124) has yielded slightly more than any other variety. The yields in this table are based on a weight of 50 pounds to the bushel.

Table XXXVII.—*Annual and average yields obtained in a varietal test with proso at Amarillo, Tex., for the five years from 1907 to 1911, inclusive.*

| C. I. No. | Variety. | Yield of grain per acre (bushels). | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
| 27 | Black Voronezh | 9.25 | 19.50 | 4.14 | 12.20 | 16.85 | 12.39 |
| 43 | White | 5.20 | 17.40 | .04 | 11.75 | 20.20 | 10.91 |
| 39 | ....do | 7.36 | 15.40 | .00 | 12.25 | 18.45 | 10.69 |
| 125 | Early Fortune | ..... | 16.20 | 4.39 | 8.35 | 14.65 | 10.89 |
| 124 | Yellow | ..... | ..... | 2.19 | 12.35 | 19.50 | 11.34 |

### FLAX.

Flax is a crop that is attracting much attention in the Panhandle region, though very little has been grown. A farmer living about 9 miles northeast of Amarillo reports an average yield of 15 bushels per acre on 250 acres, and 22 bushels per acre on 11 acres planted somewhat later. This statement has been widely circulated and many inquiries have been received at the station regarding the growing of flax. This crop has been tested in short rows, but not in field plats, except that some plats were seeded in 1911 on which the germination was very poor. The thin stand obtained permitted the weeds to grow and they soon choked the flax. Experiments with this crop will be continued on a larger scale.

### BUCKWHEAT.

Very little has been done with buckwheat at Amarillo. Four varieties sent out by the Office of Cereal Investigations were planted in the summer of 1909. They were planted late—July 22—and made a very poor growth. Some seed was matured, but the straw was so short that it was impossible to harvest the crop.

## EXPERIMENTS WITH CORN.

### VARIETAL TESTS.

A great many varieties of corn have been tested at this station. The seed was obtained from widely different sources, including several foreign countries as well as many of the States. Corn has proved to be one of the poorest grain crops for the Panhandle country. It is much poorer than is indicated by the average yields. Sometimes,

FIG. 11.—View of a portion of the grain-sorghum, corn, and forage-sorghum plats at the Amarillo Cereal Field Station, Amarillo, Tex., in October, 1906.

when the crop has yielded well, the corn has been so badly worm-eaten that it was of little value. It was not a safe feed for any live stock except hogs, on account of the worm dust. The low yields have been due to drought, cool nights, and the attacks of various insects. Corn is not recommended as a crop for the Texas Panhandle, as other crops, particularly the grain sorghums, can be grown much more successfully. The poor growth of corn, as compared with the grain and forage sorghums, is shown in figure 11, though the crop of corn here shown, that of 1906, was one of the best produced at Amarillo.

Table XXXVIII gives the results of the varietal tests with corn. The varieties are grouped according to the number of years they have been grown, and are placed in each group in the order of their yields. It will be noted that less than half of the varieties which have been tested were still grown in 1911. Many of those remaining will be discarded later.

TABLE XXXVIII.—*Annual and average yields obtained in a test of varieties of corn at Amarillo, Tex., for the six years from 1906 to 1911, inclusive.*

| C.I. No. | Name. | Kind of grain. | Source. | Yield of grain per acre (bushels). | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
| | Turney's June | White dent | Channing, Tex. | 45.42 | 15.28 | 0 | 0.54 | 3.96 | 5.71 | 11.81 |
| | Squaw | Purple flint | Dalhart, Tex. | 22.80 | 6.57 | 0 | 1.07 | 18.57 | 2.71 | 8.62 |
| | Channing Red | Red dent | Channing, Tex. | 9.42 | 14.17 | 12.85 | 2.49 | 7.80 | 4.00 | 8.45 |
| 110 | Golden Beauty | Yellow dent | Kansas | 13.71 | 9.00 | 7.28 | .23 | 5.85 | 4.85 | 6.73 |
| | Eubank's Yellow | do | Channing, Tex. | | 10.15 | 10.14 | .45 | 10.42 | 6.42 | 7.51 |
| | United States Selection No. 133. | do | Corn Investigations | | 5.07 | 18.94 | .50 | 3.85 | 7.85 | 7.24 |
| 129 | Purple Dent | Purple dent | New Mexico | | 10.71 | 0 | .35 | 15.00 | 4.42 | 6.09 |
| | Eldridge Red | Red flint | Channing, Tex. | | 13.32 | 0 | 2.39 | 7.67 | 5.57 | 5.79 |
| 58 | Jaune | Yellow flint | Argentina | | 11.78 | 0 | 1.07 | 11.25 | 4.00 | 5.62 |
| 52 | Algerian | do | France | | 10.95 | 0 | 0 | 4.46 | 5.14 | 4.11 |
| 59 | Andalusian | do | Spain | | 9.99 | 0 | 1.42 | 3.92 | 4.14 | 3.89 |
| 111 | Yellow | do | China | 5.71 | | 0 | .35 | 2.68 | 1.14 | 1.98 |
| 133 | Moqui Black | Black flint | Tuba, Ariz. | | | 14.05 | 3.33 | 13.21 | 1.92 | 8.12 |
| 123 | Mexican June | White dent | Hugoton, Kans. | | | 16.71 | 2.50 | 4.64 | 3.42 | 6.82 |
| | Yellow | Yellow flint | | | | | .35 | 11.42 | 5.00 | 5.59 |
| 149 | Cocke's Prolific | White dent | West Raleigh, N. C. | | | | .42 | 9.28 | 4.85 | 4.85 |
| 151 | Golden Glow | Yellow dent | Madison, Wis. | | | | 1.42 | 3.39 | 8.71 | 4.50 |
| | Munson | White dent | Sherman, Tex. | | | | .71 | 10.53 | 1.42 | 4.22 |
| 140 | Yellow Dent | Yellow dent | Ulysses, Kans. | | | | 0 | 2.85 | 9.57 | 4.14 |
| 144 | Reid's Yellow Dent | do | Ames, Iowa | | | | .47 | 6.07 | 4.64 | 3.72 |
| | Pittman | White dent | Amarillo, Tex. | | | | 1.42 | 7.14 | 2.42 | 3.66 |
| | Texola June | do | Sherman, Tex. | | | | 1.42 | 4.19 | 4.85 | 3.48 |
| | Hadley's Yellow Dent. | Yellow dent | Coldwater, Kans. | | | | 1.19 | 5.71 | 3.00 | 3.30 |
| 143 | Iowa Silvermine | White dent | Ames, Iowa | | | | .71 | 4.82 | 2.28 | 2.60 |
| | Ferguson's Laguna | do | Sherman, Tex. | | | | 1.42 | 2.49 | 2.71 | 2.20 |
| | Ferguson's Gourd Seed. | do | do | | | | 1.42 | 2.85 | .21 | 1.49 |
| | Rice Pop | Pop | Amarillo, Tex. | | | | | 3.39 | .85 | 2.12 |
| | Stowell's Evergreen. | Sweet | Corn Investigations | | | | | 2.34 | .28 | 1.31 |
| | Queen June | White dent | Channing, Tex. | 27.14 | 13.80 | 5.71 | 0 | | | |
| | Strawberry | Strawberry dent. | do | 21.48 | 7.49 | 0 | | | | |
| | Marlboro's Prolific | White dent | Bennettsville, S. C. | 13.14 | 6.98 | 0 | | | | |
| | McAulay's Prolific | do | Corn Investigations | 12.85 | 4.83 | 0 | | | | |
| | Leidigh's Yellow | Yellow dent | Hutchinson, Kans. | 19.86 | 3.57 | | | | | |
| | Leidigh's White | White dent | do | 11.60 | 5.00 | | | | | |
| | Throckmorton's June. | do | Channing, Tex. | 25.71 | | | | | | |
| 69 | Yellow | Yellow | Italy | 20.71 | | | | | | |
| | Yellow Flint | Yellow flint | | 14.28 | | | | | | |
| | Alexander's White | White dent | Channing, Tex. | 14.28 | | | | | | |
| | Lela Red No. 1 | Red dent | Lela, Tex. | 11.42 | | | | | | |
| | Mexican June | | | 10.71 | | | | | | |
| | Mexican Red | | | 9.42 | | | | | | |
| | Lela Red No. 2 | Red dent | Lela, Tex. | 9.42 | | | | | | |
| | United States Selection No. 120. | White dent | Corn Investigations | 9.42 | | | | | | |
| | Hildreth's Yellow | Yellow dent | Altamont, Kans. | 8.71 | | | | | | |
| | United States Selection No. 99. | White dent | Corn Investigations | 8.00 | | | | | | |
| | Eubank's Red | Red dent | Channing, Tex. | 6.42 | | | | | | |
| | Coon's Yellow Dent. | Yellow dent | Dalhart, Tex. | 6.42 | | | | | | |
| 125 | Laguna | White dent | Galveston, Tex. | | 14.04 | 0 | .71 | 1.60 | | |
| | do | do | Corn Investigations | | 16.19 | 4.06 | 0 | | | |
| 128 | Yellow Dent | Yellow dent | Scott, Kans. | | 8.57 | 0 | | | | |
| | Eubank's June | White dent | | | 24.11 | | | | | |
| 127 | | Yellow dent | Monon, Colo. | | 10.71 | | | | | |
| 124 | Yellow Dent | do | Hugoton, Kans. | | 7.50 | | | | | |
| 89 | Red Flint | Red flint | Madagascar | | 6.42 | | | | | |
| | Mexican June × Yellow Dent. | Yellow dent | New Mexico | | 5.71 | | | | | |
| 131 | Moqui White | White flint | Tuba, Ariz. | | | 15.08 | 3.21 | 3.39 | | |
| 132 | Moqui Red | Red flint | do | | | 13.14 | 1.19 | 3.03 | | |
| 134 | Mexican Black | Black dent | do | | | 4.37 | .71 | .71 | | |
| 114 | White Flint | White flint | Hungary | | | 0 | | | | |
| 147 | Eight-Row Flint | do | Ames, Iowa | | | 0 | | | | |
| 146 | Northwestern Dent. | Yellow dent | Rosser, Manitoba | | | 0 | | | | |
| | Chisholm | White dent | Sherman, Tex. | | | | 2.14 | 4.28 | | |
| | Surecropper | do | do | | | | 1.42 | 4.82 | | |
| 145 | Boone County White | do | Ames, Iowa | | | | 1.42 | 3.92 | | |
| | Ferguson's Yellow Dent. | Yellow dent | Sherman, Tex. | | | | 1.42 | 2.85 | | |

TABLE XXXVIII.—*Annual and average yields obtained in a test of varieties of corn at Amarillo, Tex., for the six years from 1906 to 1911, inclusive*—Continued.

| C. I. No. | Name. | Kind of grain. | Source. | Yield of grain per acre (bushels). | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
| 152 | Golden Dent | Yellow dent | Fargo, N. Dak | | | | 1.42 | 1.67 | | |
| 142 | Legal Tender | do | Emerson, Iowa | | | | .71 | | | |
| 141 | Silvermine | White dent | McLoud, Okla | | | | 0 | 1.26 | | |
| | Popcorn | White pop | Amarillo, Tex | | | | .14 | .73 | | |
| 150 | Silver King | White flint | Madison, Wis | | | | 1.07 | | | |
| 148 | Smith's Ninety-Day | Yellow dent | Ames, Iowa | | | | .71 | 6.07 | | |
| | Country Gentleman | Sweet | Corn Investigations | | | | | .28 | | |
| | Streeter's Hybrid | do | do | | | | | .04 | | |

The largest yield for the 6-year period from 1906 to 1911, inclusive, was obtained from a local variety known as Turney's June, while two other local varieties ranked second and third. The superiority of Turney's June is due entirely to the very large yield of 45.42 bushels to the acre produced by this variety in 1906. When this year is excluded from the averages, the Channing Red, another local variety, ranks first with an average yield of 8.26 bushels to the acre, followed by Eubank's Yellow, Squaw, United States Selection No. 133, and Turney's June, in the order named.

The highest yield for the three years 1909 to 1911, in which a number of commercial varieties from other States have been grown, was produced by the Squaw, a purple flint variety, from seed obtained in the Panhandle. This variety produced an average yield of 7.45 bushels to the acre. For this period, the other leading varieties, with the acre yield of each, were as follows: Purple Dent, 6.59 bushels; Moqui Black, 6.15 bushels; Eubank's Yellow, 5.76 bushels; Yellow Flint, 5.59 bushels; "Jaune," a yellow flint variety from Argentina, 5.44 bushels; and Eldridge Red, 5.21 bushels. Of these six varieties, four are of the flint type.

These investigations indicate that varieties of corn which have been grown in the locality for a number of years may usually be expected to give better yields than those obtained from a distance, even though much attention has been devoted to the improvement of these latter varieties in the regions from which they come. There does not seem to be any marked difference in yield between the flint and dent types, though the latter is probably to be preferred because it is more easily masticated by live stock. In a region such as this, where all grains are usually very hard in texture, this is an important consideration. As already stated, however, the grain sorghums are such well-adapted and profitable substitutes that there seems to be no good reason why corn should be extensively grown in the Texas Panhandle.

In addition to the varietal test which is reported in Table XXXVIII, an experiment with corn, United States Selection No. 133, is being conducted under the direction of Mr. C. P. Hartley, Physiologist in Charge of Corn Investigations. In this experiment, which has been in progress since 1907, the object is to study the behavior of corn when planted year after year with no selection whatever. Some work with corn varieties was also begun in cooperation with the Office of Corn Investigations in 1911.

### DATE-OF-PLANTING TESTS.

The date-of-planting tests with corn have not been very extensive. The results are shown in Table XXXIX.

TABLE XXXIX.— *Yields obtained in date-of-planting tests with corn at Amarillo, Tex.*

| Bloody Butcher, a red dent variety. | | | Eubank's June variety. | |
|---|---|---|---|---|
| Date of planting. | Distance between stalks. | Yield per acre. | Date of planting. | Yield per acre. |
| | *Inches.* | *Bushels.* | | *Bushels.* |
| April 25, 1908 | 18 by 42 | 23.00 | May 23, 1906 | 45.42 |
| May 15, 1908 | 18 by 42 | 26.00 | June 5, 1906 | 24.57 |
| April 24, 1909 | 24 by 42 | 7.34 | May 5, 1907 | 12.00 |
| May 15, 1909 | 24 by 42 | 2.31 | May 13, 1907 | 13.57 |
| April 25, 1910 | 24 by 42 | 2.85 | May 20, 1907 | 19.85 |
| May 7, 1910 | 24 by 42 | 7.14 | May 27, 1907 | 15.42 |
| May 17, 1910 | 24 by 42 | 9.42 | ..... | ..... |

The Bloody Butcher variety reported in Table XXXIX is a red dent corn obtained in the locality, which is similar to the Channing Red and the Eldridge Red used in the varietal test. In 1908 and 1910 the later planting gave the higher yield, while the reverse was the case in 1909. The best yields of June corn (Table XXXIX) were obtained in 1906 and also in 1907 from plantings made about May 20. While the data presented are not conclusive, and variation is necessary from year to year according to climatic conditions, it is probable that better results are ordinarily to be obtained in the Panhandle from corn planted about May 15 than from that planted at an earlier date.

### RATE-OF-PLANTING TESTS.

In the experiments with corn at Amarillo, planting has generally been rather thick and the plants afterwards thinned to the desired stand. The rows were from 3½ feet to 3 feet 8 inches apart, with the plants 2 feet apart in the row. In years when the rainfall was abundant this stand is about right, but in years of drought a much greater distance between the plants is required. In 1907 a test was made of different distances between the stalks on plats of Eldridge

Red corn after wheat and after sorghum. The rows were 44 inches apart in all cases. From the plats which were grown after wheat a yield of 8.28 bushels to the acre was obtained where the stalks were 52 inches apart in the row, while 7.42 bushels were produced where they were 46 inches apart. Similarly, on the plats after sorghum the yields were 5.99 and 4.42 bushels, respectively, for row spacings of 49 and 44 inches. In both cases the larger yield was obtained from the thinner planting.

### SOIL-PREPARATION TESTS.

Experiments with different methods of planting and cultivating corn were begun in 1906. In tests of sod land broken the previous fall surface-planted corn on spring plowing which was cultivated twice yielded 7.42 bushels to the acre and that cultivated five times yielded 8.57 bushels. Corn which was listed after spring plowing yielded 5.85 bushels when cultivated twice, and the same yield was obtained when it was cultivated five times. These results (Table XL) were obtained in experiments conducted by the Office of Dry-land Agriculture.[1] On sod broken the previous summer and backset in September, surface planting yielded 13.21 bushels, shallow listing 11.14 bushels, and deep listing 11.67 bushels. The last-named results are all average yields from two plats each, all of which were cultivated five times. These experiments indicate that surface planting is to be preferred to listing, while little is to be gained in this region by cultivating more than twice, unless it is necessary to prevent the formation of a crust on the soil. The common red dent variety was used in this experiment.

TABLE XL.—*Annual and average yields obtained in soil-preparation tests with corn at Amarillo, Tex., for the years 1908, 1909, and 1911.*[2]

| Preparation and condition of the field. | Yield per acre (bushels). | | | |
|---|---|---|---|---|
| | 1908 | 1909 | 1911 | Average. |
| Shallow spring plowing after corn | 20.28 | 0.57 | 8.10 | 9.65 |
| Deep fall plowing after corn | 22.85 | 2.71 | [3] 9.20 | 11.58 |
| Clean-tilled summer fallow | 27.57 | 6.42 | 9.30 | 14.43 |
| Deep fall plowing and subsoiled after corn | 25.71 | 1.71 | [3] 7.10 | 11.51 |
| Listed in spring after corn, ordinary cultivation | 25.28 | 7.28 | 7.60 | 13.38 |
| Listed in spring after corn, good cultivation to conserve moisture. | 24.14 | 3.35 | 7.90 | 11.79 |
| Deep fall plowing after oats | 18.36 | [4] | 9.80 | 9.38 |
| Deep spring plowing after oats | 12.85 | [4] | 10.30 | 7.71 |
| Deep fall plowing after winter wheat | 23.11 | [4] | 7.36 | 10.16 |
| Deep spring plowing after spring wheat | 14.28 | [4] | 9.20 | 7.82 |
| Deep fall plowing after spring wheat | 18.95 | [4] | 9.00 | 9.31 |
| Deep spring plowing after barley | 17.00 | [4] | 9.00 | 8.66 |

[1] See footnote on p. 47.
[2] The 1910 crop is not included, as it was grown on new land.
[3] Deep spring plowing, as the soil was too dry to plow the previous fall.
[4] These plats were not husked, though all were better in yield of fodder than the poorly plowed, subsoiled, or fall-plowed plats for which yields are reported.

## EXPERIMENTS WITH GRAIN SORGHUMS.

The grain sorghums are very well adapted to the Panhandle country and are the most dependable crops that can be grown. The growing of these feed crops will make stock farming, an occupation for which the Panhandle is admirably adapted, a most important industry. A great deal of work has been done with grain sorghums at Amarillo, more perhaps than with any of the other grains. These experiments were under the direction of Mr. Carleton R. Ball, Agronomist in Charge of Grain-Sorghum Investigations, and the data are in his possession. These data have been drawn upon by Mr. Ball in a number of bulletins.[1] To illustrate how these data have been used, the following quotation from one of these publications is given.[2]

> The results of four years' experiments at the Amarillo Experiment Farm, Amarillo, Tex., indicate that in general the kaoliangs yield best with a stand of 1 stalk in each 5 or 6 inches of row; the milos and durras with 1 stalk in each 7 or 8 inches of row; and the kafirs with 1 stalk to each 9 or 10 inches of row. In all cases the rows are 3½ feet apart, and as far as possible the seeds are dropped singly in the rows. Under these conditions improved varieties in each of the three distinct groups give approximately the same yields. The Amarillo Experiment Farm has an elevation of 3,600 feet and an average rainfall of 22 inches, the larger part of which comes during the growing season. Further investigations, continuing the experiments through a longer period of years, may discover that better average yields will be produced at other spacings than those noted above.

### VARIETAL TESTS.

The different phases of the grain-sorghum experiments are not discussed in detail here, as a bulletin covering this work is in preparation. In Table XLI the annual and average yields of the varieties grown in field plats from 1906 to 1911, inclusive, are given. These averages include the poor plats each year as well as the good ones. For this reason the yields here reported are approximately those that can be expected from the ordinary methods of farming.

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[1] Farmers' Bulletin 322, Milo as a Dry-Land Grain Crop, 1908; Farmers' Bulletin 448, Better Grain-Sorghum Crops, 1911; Bulletin 175, Bureau of Plant Industry, The History and Distribution of Sorghum, 1910; Bulletin 203, Bureau of Plant Industry, The Importance and Improvement of the Grain Sorghums, 1911; and Bulletin 253, Bureau of Plant Industry, The Kaoliangs: A New Group of Grain Sorghums, 1913.

[2] Farmers' Bulletin 448, Better Grain-Sorghum Crops, p. 29. 1911.

TABLE XLI.—*Annual and average yields of grain-sorghum varieties at Amarillo, Tex., for the six years from 1906 to 1911, inclusive.*[1]

| Variety. | Yield per acre (bushels). | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | Average. |
| Milo | ..... | 23.93 | 35.62 | 6.14 | 19.67 | 32.28 | 23.52 |
| Dwarf milo | ..... | ..... | 41.37 | 11.00 | 20.68 | 38.24 | 27.82 |
| White milo | ..... | ..... | ..... | ..... | 14.73 | 31.51 | 23.12 |
| White durra | ..... | ..... | 33.29 | 11.51 | 10.60 | 32.44 | 21.96 |
| Buff durra | ..... | ..... | 33.88 | 8.80 | 7.22 | 22.32 | 18.05 |
| Durra-kafir hybrids | ..... | ..... | 35.07 | 4.23 | 12.35 | 29.93 | 20.39 |
| Blackhull kafir | 44.36 | 18.91 | 33.82 | 5.04 | 9.66 | 21.24 | 22.17 |
| Red kafir | 42.85 | ..... | 33.05 | 3.81 | 5.21 | 18.68 | 20.72 |
| White kafir | ..... | ..... | ..... | 8.67 | 9.46 | 25.01 | 14.38 |
| New African kafirs | ..... | ..... | ..... | 5.37 | 4.61 | 24.42 | 11.46 |
| Blackhull kaoliang | ..... | ..... | 43.10 | 9.44 | 6.92 | 25.40 | 21.21 |
| Brown kaoliang | ..... | ..... | 29.71 | 13.04 | 10.45 | 22.09 | 18.82 |
| White kaoliang | ..... | ..... | 18.10 | 14.27 | 10.72 | 25.40 | 17.12 |
| Shallu | 26.10 | ..... | (2) | ..... | .40 | 17.20 | 14.57 |
| Milo hybrids | ..... | ..... | ..... | ..... | 9.60 | 22.00 | 15.80 |

[1] In this table, the average for each crop is taken from all the plats of that crop grown at the farm that year, regardless of the special tests in which they were included. In a number of cases this greatly reduced the average yield. For example, the brown kaoliangs included a large number of different strains, some of which were very low yielders. The table, however, gives a general idea of what these crops will do under ordinary conditions.

[2] The crop of shallu for 1908 lodged very badly before ripening and was not harvested. The estimated yield was 15 bushels, but this is not used in the table. In 1909 no shallu was planted.

Only one variety, the Blackhull kafir, has been grown continuously during the six-year period from 1906 to 1911. The average yield of all tests of this variety is 22.17 bushels to the acre, as compared with 11.81 bushels of Turney's June, the leading variety of corn in the varietal test. For the five years from 1907 to 1911, milo has produced an average yield of 23.52 bushels, Blackhull kafir 17.73 bushels, and Channing Red, the leading variety of corn for this period, only 8.26 bushels. A number of varieties have been grown for the four years from 1908 to 1911, inclusive. For this period the best average yield was produced by Dwarf milo, 27.82 bushels, followed by ordinary milo with 23.43 bushels, white durra with 21.96 bushels, and Blackhull kaoliang with 21.21 bushels. The leading variety of corn yielded only 7.45 bushels to the acre for the same period. At present, milo and kafir are most generally to be recommended for the Panhandle region. Part of a row of Dwarf milo in the breeding plat at Amarillo is shown in figure 12.

### SOIL-PREPARATION TESTS.

In Table XLII the results obtained in the soil-preparation experiments for milo and kafir conducted by the Office of Dry-Land Agriculture are presented.[1] In 1907, standard milo (C. I. No. 235), was used in this test; in 1908, Dwarf milo (C. I. No. 236); and in 1909 and 1911, standard milo (C. I. No. 234). Blackhull kafir has been used in all the experiments with that crop.

[1] See footnote on p. 47.

TABLE XLII.—*Annual and average yields obtained in soil-preparation tests with milo and kafir at Amarillo, Tex., in 1907, 1908, 1909, and 1911.*[1]

| Preparation and condition of the field. | Yield per acre (bushels). | | | | |
|---|---|---|---|---|---|
| | 1907 | 1908 | 1909 | 1911 | Average. |
| Preparation for milo: | | | | | |
| Shallow spring plowing after milo | 18.73 | 41.78 | 2.7 | 35.3 | 24.96 |
| Deep fall plowing after milo | 22.32 | 33.92 | 1.0 | [2] 31.4 | 22.54 |
| Listed in spring after milo and planted at once | 32.85 | 39.28 | 11.1 | 17.4 | 22.77 |
| Deep fall plowing after winter wheat | 28.87 | 48.12 | 10.4 | 26.4 | 28.39 |
| Preparation for kafir: | | | | | |
| Shallow spring plowing after kafir | 11.42 | 29.66 | 2.2 | 22.4 | 14.11 |
| Deep fall plowing after kafir | 14.28 | 31.35 | 1.6 | [2] 22.4 | 17.52 |
| Listed in spring after kafir and planted at once | 12.67 | 27.62 | 5.7 | 8.3 | 13.39 |
| Deep fall plowing after winter wheat | 17.85 | 38.97 | 4.8 | 19.6 | 19.95 |

[1] The 1910 crop is not included, as it was grown on new land.
[2] Deep spring plowing, as the land was too dry to plow in the fall.

FIG. 12.—Portion of a head row of Dwarf milo in the breeding experiments at the Amarillo Cereal Field Station, Amarillo, Tex.

## EXPERIMENTS WITH BROOM CORN.

Broom corn is another sorghum which is adapted to the Panhandle country and which promises to be one of the money crops. It is already grown to some extent, but is not a regular crop. Individual farmers try it for a year or so and then give it up because of a poor crop or low prices or because they find they do not understand how to

handle it. There are a few men, however, who grow broom corn regularly and who seem to find the crop a profitable one.

Aside from the breeding of a dwarf strain of standard broom corn, very little work has yet been done with this crop at the Amarillo station. A few rows have been grown each year for several years and head selections have been made and studied. More extensive work is now in progress, but no data as to yields are yet available. The growth, cultivation, and general care of broom corn in the field are very similar to that of the other sorghums. The harvesting, curing, baling, and storing of the brush, on the other hand, are problems altogether different from those met with in the growing of either grain sorghums or forage sorghums.

## CEREAL-DISEASE EXPERIMENTS.

Much cereal-disease work of the Office of Cereal Investigations has been done at the Amarillo station, and the field investigations of the diseases of sorghum have been concentrated there since 1907, 10 to 30 tenth-acre plats having been used each year. Other diseases which have been studied include the loose smuts of wheat and barley, the stinking smut of wheat, covered smut of barley, and oat smut.

### THE SORGHUM SMUTS.

The life history of the kernel smut of sorghum (*Sphacelotheca sorghi* (Link.) Clint.), has been investigated for this region. This smut lives from year to year as spores, which get on the seed in thrashing and handling. When such smutted seed is planted, the smut again occurs in the crop. All varieties of sorghum, with the exception of milo, are subject to the attack of this disease. The life history of the head smut of sorghum (*Sphacelotheca reiliana* (Kuhn) Clint.), heretofore unknown, has been worked out and will be described in a forthcoming bulletin. A third smut (*Ustilago cruenta* Kuhn), very similar to kernel smut, has recently been found at Amarillo. In 1911 it was shown that it lives from year to year exactly as does the kernel smut.

A very satisfactory treatment for the prevention of kernel smut has been tested at Amarillo. This consists in soaking the seed in a solution of 1 pound of formalin to 30 gallons of water for 1 hour. The seed can be sown immediately after treatment or, if dried carefully, can be kept for weeks or months without injury to the germination. This treatment is also effective for the new kernel smut.

A large number of treatments have been tried for the head smut, but none has yet been found effective. The only way now known to reduce this smut is to remove all smutted plants as they appear and to burn them so as to destroy all the spores, but it is hoped, from recently acquired knowledge of its life history, that specific preventive

measures may be developed. Circular No. 8 of the Bureau of Plant Industry on the smuts of sorghum has been published as a result of the work done at Amarillo. This circular describes both the kernel smut and the head smut and discusses various methods for their prevention.

### THE LOOSE SMUTS OF WHEAT AND BARLEY.

Considerable field work has been done on the loose smuts of wheat and barley. These smuts have been very abundant in some varieties of these grains at this station. A large number of varieties have been treated with the modified hot-water treatment. This consists of soaking the seed in cold water for 5 hours and then treating it in hot water at 54° C. for 10 minutes for wheat or at 52° C. for 15 minutes for barley. This treatment was found to be effective in preventing the loose smuts. These smuts, with the treatments for their control, are fully described by Freeman and Johnson in Bulletin No. 152 of the Bureau of Plant Industry.

### THE STINKING SMUT OF WHEAT, SMUT OF OATS, AND COVERED SMUT OF BARLEY.

Little experimental work has been done on stinking smut of wheat, oat smut, and covered smut of barley at Amarillo. These smuts, however, have been found in many of the varieties. In order to prevent them, the seed has been treated with a formaldehyde solution composed of 1 pound of 40 per cent formaldehyde (formalin) to 40 gallons of water. This treatment is very effective and is now applied every year to all of the varieties in the field plats in order to keep the station free from these smuts.

## EXPERIMENTS WITH FORAGE CROPS.

Various experiments with forage crops have been conducted cooperatively at the Amarillo field station by the Office of Forage-Crop Investigations since the farm was established. Two publications have been prepared by the Office of Forage-Crop Investigations, containing in part the data resulting from these experiments. These are Bulletin 102 of the Texas Agricultural Experiment Station, entitled "Forage Crops for Northwest Texas," and Farmers' Bulletin 458 of the United States Department of Agriculture, entitled "The Best Two Sweet Sorghums for Forage."

## EXPERIMENTS WITH MISCELLANEOUS CROPS.

### SUGAR BEETS.

The experiments with sugar beets at the Amarillo station were conducted in cooperation with and under the direction of Dr. C. O. Townsend, formerly pathologist in charge of sugar-beet investigations

of the Bureau of Plant Industry. The detailed results are now on file in that office. A number of experiments were conducted in 1907. In 1908 no stand was secured, though two plantings were made. In 1909, 20 twentieth-acre plats were grown with a different variety on each plat. No attempt is made here to give the details of these experiments. Table XLIII gives briefly the average results for the two years the sugar beets were grown. The highest yield, the highest percentage of sugar in juice, and the highest coefficient of purity are also given for each year. The highest results in the three columns were not obtained on the same plats. The highest yield was obtained on one plat, the highest percentage of sugar in juice from another, and the highest coefficient of purity from a still different plat.

TABLE XLIII.— *Yield, sugar content, and coefficient of purity obtained in tests of sugar beets at Amarillo, Tex., in 1907 and 1909.*

| Statement of averages. | Yield per acre. | Sugar content in juice. | Coefficient of purity. |
|---|---|---|---|
| | *Pounds.* | *Per cent.* | *Per cent.* |
| Average for 1907 | 12,365 | 17.81 | 82.34 |
| Average for 1909 | 5,414 | 16.67 | 78.86 |
| Average for two years | 8,889 | 17.24 | 80.60 |
| Highest for 1907 | 20,620 | 22.40 | 88.90 |
| Highest for 1909 | 8,780 | 18.40 | 84.00 |

## COTTON.

A great many questions about the cotton crop are asked by people looking for investment or homes in the Panhandle country. Cotton is not grown commercially nearer than 100 miles to the south and east of Amarillo. Very little experimenting has been done with cotton, either at the station or by the farmers in this region. The office in charge of cotton investigations has not undertaken any work in the Panhandle, but two experiments have been made by the farm superintendent, one in 1909 and the other in 1911.

The seed for the first experiment was furnished by Mr. J. H. Avery, of Amarillo, Tex., who was then acting as secretary of the Amarillo Chamber of Commerce. This seed was at least two years old when planted. The notes are briefly as follows: Approximately a twentieth-acre plat was planted May 17, 1909, half of which was on fall-plowed wheat land and half on cowpea land, double disked in the spring. The soil was in good condition but rather dry. The cotton was seeded quite thickly in rows 2 feet apart. The plants appeared above the ground on May 31. When they reached a height of 6 or 8 inches they were thinned to one plant to every 10 or 12 inches of

row. Good level cultivation was given. The plants attained a height of 15 inches, with an estimated average of 15 bolls to the plant, most of which matured. The first picking was made on October 2. Other pickings were made at intervals during the month of October. A total of 17 pounds of seed cotton was picked from the plat. This is at the rate of 340 pounds of seed cotton per acre.

The seed for the second experiment was furnished by Mr. O. B. Burnett, of Memphis, Tex. It was from a strain of cotton he has been improving for a number of years. A tenth-acre plat was planted May 27 on spring-plowed cowpea land in rows 3½ feet apart, coming up unevenly on June 7. It was not thinned, as the stand was thin enough, though rather uneven, averaging about 12 inches between plants in the row. Good cultivation was given. Squares began forming on July 22, and the first blossom appeared during the first week in August. The first boll opened on September 23, but the crop was not picked until December 11 and 12. The picking was done late in order to test the ability of the bolls to hold the lint. About 2 per cent (estimated) of the lint was blown out. The yield per plat was 65 pounds of seed cotton, or 650 pounds per acre.

Further testing will have to be done before it will be safe to draw any very definite conclusions in regard to the growing of cotton in this region. It is rather doubtful if it will ever make a successful crop here.

## EXPERIMENTS AT DALHART.

In 1907 a farm and permanent equipment for experimental work at Dalhart, Tex., was placed at the disposal of the Office of Cereal Investigations. This farm finally was organized as one of the field stations of the Office of Dry-Land Agriculture. Dalhart is 81 miles northwest from Amarillo. Conditions at the two places are very similar, except that the soil at Dalhart is more sandy than that at Amarillo. The experiments with cereals have therefore been confined chiefly to varietal tests in order to determine varieties adapted to that soil type. The general results of these tests are herein given.

### VARIETAL TESTS OF CEREALS.

The small-grain tests in 1908 were entirely destroyed by hail on June 15. The season was very dry, there being but 12.28 inches of rain during that year. The grain sorghums were also destroyed by hail. Some of the varietal plats were replanted later, but none matured. Six plats of milo grown in various tillage and rotation tests by the Office of Dry-Land Agriculture gave an average yield of 26.8 bushels to the acre, but the replanted kafir did not mature grain, though making good yields of fodder.

The year 1909 was a very severe one for all grains. Yields were obtained from winter wheats, winter rye, spring wheats, proso, and milo. Complete failures occurred in the case of winter barley, winter oats, and winter emmer. Most of the grain sorghums were planted too thickly and did not survive the extreme summer drought. Two plats of milo, which were more favorably located to accumulate spring run-off water than the remainder of the plats, gave an average yield of 26 bushels to the acre.

In 1910 the variety tests of small grains were entirely destroyed by the blowing and drifting of the soil. The grain-sorghum varieties made an excellent crop.

### WINTER SMALL GRAINS IN 1909.

The winter small grains harvested in 1909 were planted on land broken from sod in August, 1907, fallowed in 1908, and plowed 6 inches deep in August of that year. Practically no rain fell in August, September, October, and November, 1908. The seeding was done on November 24, having been delayed on account of the dry weather. There was snow equaling 0.93 inch of precipitation on November 27. Much of the grain germinated but made no appreciable growth before winter. The yields obtained from the varieties of wheat and rye are shown in Table XLIV.

TABLE XLIV.— *Yields of straw and grain obtained from varieties of winter wheat and rye at Dalhart, Tex., in 1909.*

| C. I. No. | S. P. I. No. | Name. | Original source. | Yield per acre. | | Weight per bushel. |
|---|---|---|---|---|---|---|
| | | | | Straw. | Grain. | |
| | | WINTER WHEAT. | | *Pounds.* | *Bushels.* | *Pounds.* |
| 1558 | 11610 | Turkey | Russia | 1,990 | 16.83 | 60 |
| 1561 | 5498 | Theiss | Austria | 1,840 | 16.83 | 60 |
| 1559 | ..... | Crimean | Hungary | 1,820 | 16.33 | 58 |
| 2902 | ..... | Mammoth Red | Oklahoma | 1,630 | 15.33 | 60 |
| 2943 | ..... | Hard red winter | Local | 1,450 | 12.50 | 59 |
| 2223 | 11229 | Turkey | Russia | 1,290 | 11.83 | 60 |
| 1543 | 6012 | Beloglina | do | 1,700 | 11.67 | 59 |
| 1437 | 5636 | Crimean | do | 1,600 | 11.67 | 57 |
| 1563 | 5499 | Weissenberg | Austria-Hungary. | 1,750 | 11.67 | 58 |
| 1560 | 5496 | Banat | do | 1,550 | 11.67 | 60 |
| 1562 | 5498 | Bacska | do | 1,530 | 11.67 | 58 |
| 1667 | 7787 | Beloglina | Russia | 1,460 | 11.50 | 59 |
| 2208 | 9125 | Kharkof | do | 1,940 | 11.00 | 59 |
| 1442 | 5641 | Do | do | 1,480 | 10.33 | 58 |
| 1436 | 5635 | Crimean | do | 1,310 | 9.83 | 57 |
| 1438 | 5637 | Ghirka | do | 1,490 | 9.33 | 59 |
| 2339 | 9358 | Beloglina | do | 1,200 | 9.16 | 59 |
| 1435 | 6015 | Crimean | do | 1,160 | 8.16 | 58 |
| 2398 | 9872 | Galgalos | do | 850 | 7.50 | 58 |
| 2942 | 17994 | Rieti | Italy | 850 | 6.66 | 59 |
| 1571 | ..... | Turkey | Kansas[1] | 1,750 | 5.00 | 60 |
| 2092 | 7430 | Jejar | Spain | 900 | 4.17 | 56 |
| 1395–2 | ..... | Diehl Mediterranean | ..... | ..... | 3.33 | 56 |
| | | WINTER RYE. | | | | |
| 114 | ..... | Kansas | Kansas | 1,850 | 5.36 | 55 |
| 34 | 10367 | Ivanov | Russia | 1,600 | 5.36 | 55 |

[1] Originally from Kansas, but the seed used for this crop had been grown for several years previously in British Columbia.

SPRING SMALL GRAINS IN 1909.

Twenty-seven varieties of spring wheats were tested on tenth-acre plats in 1909. Most of these varieties failed by reason of a combination of drought and soil blowing. Since these failures were not wholly due to the varieties themselves, the varieties destroyed are not reported. Yields of the remainder are found in Table XLV. The yields obtained from five varieties of proso are also included.

TABLE XLV.— *Yields of straw and grain obtained in a varietal test of durum and common spring wheat and proso at Dalhart, Tex., in 1909.*

| C. I. No. | S. P. I. No. | Name. | Original source. | Yield per acre. | | Weight per bushel. |
|---|---|---|---|---|---|---|
| | | | | Straw. | Grain. | |
| | | DURUM WHEAT. | | | | |
| | | | | *Pounds.* | *Bushels.* | *Pounds.* |
| 2246 | 10364 | Kubanka | Russia | 1,530 | 7.83 | 59 |
| 2575 | ..... | Cavarna | Bulgaria | 1,130 | 7.83 | 60 |
| 2537–I–I | ..... | Marchard | Algeria | 1,100 | 6.67 | 58 |
| 2545–I | ..... | Semonlier | ....do | 960 | 5.67 | 59 |
| 2689 | ..... | | Italy | 870 | 5.50 | 58 |
| 2692 | ..... | Realforte | ....do | 640 | 1.83 | 58 |
| | | COMMON WHEAT. | | | | |
| 2398 | 9872 | Galgalos | Russia | 1,950 | 14.17 | 58 |
| | | PROSO. | | | | |
| 27 | 9425 | Black Voronezh | ..... | 1,700 | 10.00 | ..... |
| | 22422 | | ..... | 700 | 5.00 | ..... |
| | ..... | Native | ..... | 1,200 | 3.91 | ..... |
| 11 | 2797 | Red Russian | ..... | 1,950 | Failed. | ..... |
| 39 | ..... | White | ..... | 1,950 | ...do.... | ..... |

GRAIN SORGHUMS.

In 1909, 2½ acres were used for grain-sorghum tests. This land had been fall plowed in 1908 and given good care. Fourteen varieties were grown in a total of 23 tests of one-tenth acre each and 4 tests of one-twentieth acre each. Of these tests all failed but two one-tenth acre plats of milo (C. I. No. 235) and one one-tenth acre plat of Dwarf milo (C. I. No. 236). The two plats of milo averaged 26.5 bushels of grain per acre, while the single plat of Dwarf milo yielded at the rate of 25.4 bushels per acre. As previously noted these plats were so located as to receive a considerable amount of run-off water early in the season and thus had an advantage over the other plats.

RATE-OF-SEEDING TESTS WITH WHEAT.

The results of seeding both winter and spring wheat in 1909 at different rates are given in Table XLVI.

TABLE XLVI.— *Yields of straw and grain obtained in rate-of-seeding tests with winter and spring wheat at Dalhart, Tex., in 1909.*

| Kind of wheat. | Rate of seeding. | Yield per acre. | | Weight per bushel. |
|---|---|---|---|---|
| | | Straw. | Grain. | |
| | *Pecks.* | *Pounds.* | *Bushels.* | *Pounds.* |
| Turkey winter | 2 | 1,700 | 13.33 | 60 |
| | 3 | 1,990 | 16.83 | 60 |
| | 4 | 1,920 | 17.83 | 60 |
| | 5 | 1,940 | 18.50 | 60 |
| | 6 | 2,330 | 20.33 | 60 |
| Kubanka durum spring | 2 | 900 | 4.16 | 59 |
| | 3 | 1,380 | 6.16 | 59 |
| | 4 | 1,530 | 7.83 | 59 |
| | 5 | 1,970 | 10.50 | 59 |
| Galgalos common spring | 2 | 880 | 5.33 | 58 |
| | 3 | 1,480 | 13.67 | 58 |
| | 4 | 1,950 | 14.17 | 58 |
| | 5 | 920 | 7.83 | ..... |

Owing to winter drought and spring winds the killing of both the winter and spring wheat was very severe. The thickest plantings in this test were not too thick this year, while ordinarily they would have been so thick as to have been partly stunted. For that reason the test is of little value as an indication of the proper rate of seeding.

## EXPERIMENTS AT CHILLICOTHE.

Varietal tests of small grains have been conducted at Chillicothe, Tex., for five years. The tests at that place are made on an experiment farm operated cooperatively by the Office of Forage-Crop Investigations and the Texas Agricultural Experiment Station. The small grains grown there are but a minor part of the work of the Chillicothe station, which is primarily for the testing and improvement of forage crops. A general view of the small-grain tests at this station in 1906 is shown in figure 13.

### LOCATION, RAINFALL, AND SOIL.

Chillicothe is about 150 miles southeast of Amarillo. Its altitude is 1,500 feet, which is 2,340 feet lower than that of Amarillo. While it lies somewhat beyond the eastern edge of what is defined as the Panhandle in this bulletin, the data obtained are applicable to the eastern and lower portions of the region and so supplement those obtained at Amarillo and elsewhere. Chillicothe is about at the western edge of the older wheat-growing section of the State and may be regarded as representative of quite a large territory along both sides of the Red River and of the districts with similar elevations to the north and south.

The average rainfall is approximately 23 inches per annum, although data are not obtainable for a sufficient period of years to

establish a final conclusion. The rainfall data for the years reported are given in Table XLVII.

TABLE XLVII.—*Monthly, annual, and average precipitation, in inches, at Chillicothe, Tex., for the five years from 1906 to 1910, inclusive.*[1]

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1906 | 0 | 0 | 0.90 | 3.92 | 1.78 | 4.20 | 8.71 | 2.67 | 5.02 | 4.58 | Tr. | 0 | 31.78 |
| 1907 | 0 | 0 | 3.42 | .98 | 7.81 | 2.56 | 1.46 | 1.52 | 1.71 | 6.60 | 0.80 | 0 | 26.86 |
| 1908 | Tr. | Tr. | .28 | 3.51 | 6.40 | 8.41 | 5.68 | Tr. | 2.22 | 1.84 | 4.13 | Tr. | 32.47 |
| 1909 | 0 | 0.22 | 1.89 | 1.41 | .56 | 8.06 | .49 | 1.07 | .26 | 1.84 | 4.57 | 0 | 20.37 |
| 1910 | .64 | .08 | 1.08 | 1.39 | 2.74 | 1.91 | 1.42 | 1.74 | 1.22 | 1.30 | .14 | 0.53 | 14.19 |
| Average | .13 | .06 | 1.51 | 2.24 | 3.86 | 5.03 | 3.55 | 1.40 | 2.08 | 3.23 | 1.93 | .10 | 25.13 |

[1] Furnished by A. B. Conner, Assistant Agrostologist, Office of Forage-Crop Investigations, Bureau of Plant Industry, U. S. Dept. of Agriculture, Chillicothe, Tex.

The soil on which the station is located is a rather sandy reddish loam which contains enough of a shalelike clay to bake after hard

FIG. 13.—General view of the plats of small grain at Chillicothe, Tex., in 1906, grown in cooperation with the Office of Forage-Crop Investigations.

rains. This soil washes somewhat and will drift badly in bare, level fields during high winds.

## VARIETAL EXPERIMENTS WITH WINTER CEREALS.

The results of varietal trials of winter cereals obtained from 1906 to 1910, inclusive, are given in Table XLVIII. The land seeded in the fall of 1905 had produced a good crop of winter wheat. It was prepared just as the farmers in that locality prepare their fields. The land for the 1907 crop was in cowpeas in 1906. During the spring of 1907 the green bug or grain aphis destroyed about all the small grain in that part of the State. The fields at the station were infested, but drought and other weather conditions checked the development of the insects and a small crop of grain was obtained.

The 1908 crop was seeded in good condition on land cropped in cowpeas in 1907. An excellent crop was harvested, but most of the value of the year's work was lost because of a storm which mixed the shocked grain on part of the plats so as to render accurate yield

tests of each variety impossible. Careful notes had been made previously and it is thought that Mediterranean winter wheat (C. I. No. 1395–2) would have produced a yield of 20 bushels per acre. The mixed bundles were collected and when thrashed gave an acre yield of 14 bushels as the average of these plats.

The crop of 1909 was seeded on land which had been in cowpeas in 1908 and the prospects for a good crop were excellent. However, the winter was very severe and much winterkilling resulted from blowing soil.

The seeding in the fall of 1909 was done on cowpea land and a good stand was obtained, but the dry spring in 1910 resulted in a very small crop.

TABLE XLVIII.—*Annual and average yields obtained in varietal tests of winter grains at Chillicothe, Tex., 1906 to 1910, inclusive.*

| C. I. No. | S.P.I. No. | Name. | Kind of grain. | Origin. | 1906 | 1907 | 1908 | 1909 | 1910 | Average. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | WHEAT. | | | Bus. | Bus. | Bus. | Bus. | Bus. | Bus. |
| 2246 | 10364 | Kubanka [1] | Durum | Russia | 23.80 | [2]13.14 | 19.50 | 7.31 | 1.50 | 13.05 |
| 1564 | 12015 | Pesterboden | Hard red | Hungary | 20.40 | 7.06 | 9.50 | 8.79 | 2.66 | 9.68 |
| 1558 | 12013 | Turkey | do | Russia | 24.00 | 7.56 | | 6.36 | 3.83 | 10.44 |
| 2208 | 9125 | Kharkof | do | do | 20.30 | 9.45 | | 2.08 | 1.00 | 8.21 |
| 1561 | 12004 | Theiss | do | Hungary | 30.80 | 7.11 | | 6.79 | | 14.90 |
| 1563 | 11650 | Weissenberg | do | do | 19.50 | 5.76 | | 7.38 | | 10.88 |
| 2900–1 | | | do | | 24.60 | | | | 1.66 | |
| 1596 | 7582 | Fretes | Medium red | Algeria | 17.30 | | | | 1.83 | |
| 1436 | 12007 | Crimean | Hard red | Russia | 22.60 | 8.16 | | | | |
| 2398 | 9872 | Galgalos | Medium hard white. | do | 20.10 | 7.11 | | | | |
| 1667 | 12002 | Beloglina | Hard red | do | 21.80 | | | | | |
| 2239 | 9358 | do | do | do | 20.10 | | | | | |
| 1395–2 | | Diehl Mediterranean. | Medium hard red. | | | | | 8.05 | 4.83 | |
| | | EMMER. | | | | | | | | |
| 2337 | 11650 | Black Winter [3] | | France | 48.21 | 40.00 | 49.00 | 8.00 | 2.80 | 29.60 |
| | | RYE. | | | | | | | | |
| 34 | 10367 | Ivanov | | Russia | 19.10 | 12.56 | 15.53 | 4.87 | 1.16 | 10.64 |
| 40 | 10366 | | | | 15.00 | | | | | |
| | | BARLEY. | | | | | | | | |
| 257 | 11193 | Tennessee Winter | | | Failure. | | | | | |
| | | SPELT. | | | | | | | | |
| 1772 | | Red Winter | | | Failure. | | | | | |

[1] Tried as a winter durum. The seed was not pure and the common wheat in the mixture soon crowded out the durum. The latter gradually winterkilled until in 1910 there was none left in the crop.
[2] Average of two plats.
[3] Figured at 25 pounds per bushel.

The largest yields of wheat in these tests were produced by varieties of the hard red or Turkey type. Turkey, Kharkof, and Theiss were among those which gave the best results. As noted in the table, the Kubanka (C. I. No. 2246), which is reported as giving the highest yield, was mixed with other varieties in the earlier years of the experiment, while the plat grown under this name contained none of this

variety in 1909 and 1910. Black Winter emmer (C. I. No. 2337) averaged 29.6 bushels (about 740 pounds) for the five years, while Ivanov rye yielded 10.64 bushels (about 600 pounds) for the same period.

## SUMMARY.

The Panhandle of Texas was for many years occupied by great cattle ranches which in recent years have been offered for sale as farm lands. The need of the new settlers on such lands for information as to adapted crops and cropping methods has been and still remains very great.

Experiments designed to supply the needed information were begun by the Office of Cereal Investigations in 1903 and have been conducted without interruption since that date, first at Channing and then at Amarillo, Tex. Minor experiments have been conducted cooperatively with other offices of this bureau at Chillicothe and Dalhart, Tex.

The Panhandle includes about 47 counties in northwestern Texas. In general, it is a high, dry plain with an elevation of 2,000 to 4,000 feet. The average annual precipitation in different parts ranges from 18 to 23 inches, most of which falls during the summer months. It is a region of low humidity, high evaporation, high average wind velocity, abundant sunshine, and relatively cool nights.

The predominant soil type is a clay or clay loam with some sandy areas and some heavy clays or adobes. The grass covering on the clayey soils consists largely of buffalo grass and blue grama. On the sandier soils bluestems (*Andropogon* spp.) are especially prevalent.

### EXPERIMENTS AT CHANNING, TEX.

Experiments were conducted at Channing, Hartley County, from the autumn of 1903 to the autumn of 1906 in cooperation with the Capitol Freehold Land & Investment Co. on their XIT ranch. The crop of 1904 was nearly a complete failure, owing to new land and a drought lasting until the end of April. Results obtained in 1905 and 1906 show that hard red winter wheats, black winter emmer, and winter rye gave profitable yields. Among spring wheats Galgalos and Chul (common) wheats and Kubanka (durum) wheat were the best-yielding varieties, but none of them equaled the winter varieties. Early oats like Burt, Red Rustproof, and Sixty-Day gave only fair yields and later varieties still smaller. No spring barleys did well.

The date-of-seeding and rate-of-seeding tests were of too short duration to yield conclusive results, as were also the tests of the comparative value of fallowing and continuous cropping.

In a test of many varieties of corn the average yield of the best variety in a three-year period was less than 40 per cent of the yield of milo.

Milo and kafir proved good yielders of grain, the three-year average yield of milo being 42 bushels of 56 pounds each.

### EXPERIMENTS AT AMARILLO, TEX.

Experiments were begun at Amarillo in 1905 and transferred to the new farm at that place in 1909. Very extensive experiments, partly cooperative with other offices, have been conducted since the latter date.

Hard red winter wheats of the Turkey group and medium-hard sorts of the Mediterranean group have proved best adapted, giving yields of 7.5 to 10.5 bushels per acre for the six-year period ended in 1911. The best varieties of winter spelt and emmer have yielded 25 and 19.6 bushels, respectively, in the same period.

Tennessee Winter barley gave an average yield in the six-year period of 10.6 bushels, and the best winter rye 9 bushels, but no varieties of winter oats have proved sufficiently winter hardy.

Experiments in dates and rates of seeding of winter wheat show that 3 pecks per acre sown between October 15 and 30 gave the best average results. Cultural experiments indicate that best results will be obtained when the land is plowed at least 6 inches deep from 60 to 80 days before seeding. When the land can not be prepared until nearly seeding time disking has given better results than plowing.

Spring wheats have been somewhat lower in yield than winter wheats. The best varieties were the common wheats, Fretes and Galgalos, yielding 9.3 bushels on the average, and the durum wheats, Marouani, Saragolla, and Kubanka, yielding 8.7, 8.6, and 7.9 bushels per acre in the order named.

Experiments indicate that 4 pecks per acre for the common spring wheats and 5 pecks per acre for durum wheats are the best average rates of seeding, subject to variation with varying weather and soil conditions. The best date of seeding varies from the last of February to the middle of April, depending on conditions of weather and soil moisture.

The spring oat varieties, Red Algerian and Red Rustproof, have yielded 19.8 and 18 bushels, while different strains of Sixty-Day, Kherson, and Burt have varied between 13.6 and 17.8 bushels for the six years from 1906 to 1911. Results of rate-of-seeding tests have been contradictory, indicating that the proper rate is governed by weather and soil conditions. However, 5 pecks is probably the best rate for average conditions. Early or medium early seeding is usually to be recommended. Fall plowing for spring oats has been

found most desirable, and home-grown seed has given better results than seed of the same variety brought from a distance.

Spring barley has not given profitable yields, the best variety being the White Hooded, yielding from 5 to 7 bushels in the six-year average.

Proso (broom-corn millet) varieties have produced average yields of 10.7 to 13 bushels per acre in tests lasting from four to six years.

The results in tests of corn during the six-year period show it not to be adapted to the Panhandle country. The best variety, a June corn, yielded 11.8 bushels, and only three varieties exceeded 8 bushels per acre on an average during that time. Omitting the results of one season, a locally grown red dent has yielded slightly better than the June corn.

The grain sorghums are the most dependable crops that can be grown in the Panhandle. In the five years, 1907 to 1911, inclusive, the average yields of all varieties of milo were 23.5 bushels, while all varieties of dwarf milo in the last four years of this period yielded an average of 27.8 bushels. Blackhull and Red kafir made an average yield of 20 bushels in the six-year period, 1906 to 1911, excluding 1907 in the case of Red kafir. Varieties of durra and kaoliang also made good yields. About 3 pounds per acre is the proper rate of planting and the best date in the vicinity of Amarillo is about May 20, varying however, with the season.

Dwarf broom corn is suited to the region, but requires judgment and experience to make production profitable. It should be grown only by farmers who expect to continue growing it for a period of years and who can afford the necessary equipment to handle it properly.

Smuts of cereals are fairly common, but all destructive smuts can be easily controlled by proper treatment of the seed.

### EXPERIMENTS AT DALHART AND CHILLICOTHE, TEX.

Grain sorghums such as milo, dwarf milo, and Blackhull kafir have given profitable yields at Dalhart, though not so high as at Amarillo.

The small grains, both winter and spring varieties, have been so damaged by winter killing, spring blowing, drought, and hail, as to show no profitable yields during the period covered by the experiments.

Experiments with small grains have been conducted cooperatively with the Office of Forage-Crop Investigations at Chillicothe, which is situated in Hardeman County, somewhat east of the true Panhandle, at an elevation of only 1,500 feet and with an average annual rainfall of 23 inches. The results are similar to those obtained at Amarillo, the hard winter wheats giving the best yields and proving the most profitable small-grain crop. The grain sorghums are important and completely adapted crops, milo, dwarf milo, and Blackhull kafir being largely and profitably grown.